**Technical Support
for
Permit Modification
Application**

**Calciners A & B
Fuel Switch
OP 30-126**

<small>SOLVAY SODA ASH JV</small>

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List of Abbreviations

ACFM	Actual Cubic Feet per Minute
ARM	Acid Rain Mountain Mesoscale (Model)
ANC	Acid Neutralization Capacity
AQRV	Air Quality Related Value
ASL	Above Sea Level
ATSDR	Agency for Substances and Disease Registry
BACT	Best Available Control Technology
BLM	Bureau of Land Management
BPIP	Building Profile Input Program
CalEPA	California Environmental Protection Agency
CAM	Compliance Assurance Monitoring
CD	Compact Disk
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CTG	Composite Theme Grid
DEM	Digital Elevation Model
DEQ	Department of Environmental Quality
DEQ	Wyoming Department of Environmental Quality
EIS	Environmental Impact Study
EPA	The United States Environmental Protection Agency
eq	Equivalent
ESP	Electrostatic Precipitator
FAA	Federal Aviation Administration
FGR	Flue Gas Re-circulation
FLAG	Federal Land Managers Air Quality Related Values Workgroup
FLAG	Federal Land Managers' Air Quality Related Values Workgroup
FR	Federal Register
FS	Forest Service (USDA)
ft	Feet
g	Gram
GED	Good Engineering Design
H2H	Highest Second-Highest
H_2O	Water
HAP	Hazardous Air Pollutant
HNO3	Nitric Acid
hr	Hour
IMPROVE	Interagency Monitoring of Protected Visual Environments
IRIS	Integrated Risk Information System
ISCST	Industrial Source Complex Short Term
IWAQM	Interagency Workgroup on Air Quality Modeling
$^{\circ}$K	Degree Kelvin
l	Liter
lb	Pound
LCC	Lambert Conic Conformal
LEAR	Lowest Achievable Emission Rate
LNB	Low-NO_x Burner
m	Meter
MACT	Maximum Achievable Control Technology
μ	Micro (10^{-6})

MM5	Mesoscale Model Version 5
MMBtu	Million British Thermal Units
N	Nitrogen
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NCAR	National Center for Atmospheric Research
NDDN	National Dry Deposition Network
NESHAP	National Emission Standards for Hazardous Air Pollutants
NH_3	Ammonia
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_3	Nitrate
NO_x	Oxides of Nitrogen
NP	National Park
NPS	National Park Service
NSPS	New Source Performance Standards
NWS	National Weather Service
O_3	Ozone
OFA	Over-Fire Air
PC	Pulverized Coal
PM_{10}	Particulate Matter (with aerodynamic diameter = 10 micron)
ppb	Parts per Billion
ppm	Parts per Million
PRISM	Parameter-elevation Regressions on Independent Slopes Model
PSD	Prevention of Significant Deterioration
PSU	Penn State University
PTE	Potential to Emit
RACT	Reasonably Available Control Technology
RBLC	RACT BACT LEAR Clearinghouse
RH	Relative Humidity
RIVAD	Regional Impacts on Visibility and Acid Deposition
s	Second
SC	Stoker Coal
SCR	Selective Catalytic Reduction
SIL	Significance Impact Level
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulfur Dioxide
SO_4	Sulfate
SWWYTAF	Southwest Wyoming Technical Air Forum
Tpy	Ton per Year
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compound
VR	Visual Range
WAAQS	Wyoming Ambient Air Quality Standards
WI	Water Injection
yr	Year

SECTION 1

INTRODUCTION

Solvay Soda Ash Joint Venture (Solvay) proposes to modify two of its calciner furnace combustion systems (Calciners A and B) to be fired on coal instead of natural gas, the current fuel. These calciners were fired on coal from start-up in 1982 until conversion to gas-firing in 1995 per MD-229 issued June 13, 1995. With the proposed conversion back to coal, there will be an increase (present actual to proposed potential) in nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds (VOC), and particulate matter (PM_{10}) emissions. These increases trigger Prevention of Significant Deterioration (PSD) review. This report provides a review of the various requirements triggered by PSD rules. It also contains a facility description (Section 2), followed by a regulatory applicability review (Section 3), a control technology review (Section 4), impact reviews for both Class I and Class II areas (Sections 5 and 6), and a compliance demonstration plan (Section 7).

The Solvay facility is located in Section 31, T18N, R109W in Sweetwater County, Wyoming. The Universal Transverse Mercator (UTM) location is Zone 12, 603.7 km Easting and 4594.8 km Northing; the geographic coordinates are 41.49 N degrees latitude and 109.76 W degrees longitude. The facility location on a regional scale map is shown in Figure 1.1; a westerly view of the facility with the combined stack for Calciners A and B is shown on Figure 1.2.

Figure 1.1: Solvay Facility Location on a Regional Scale Map

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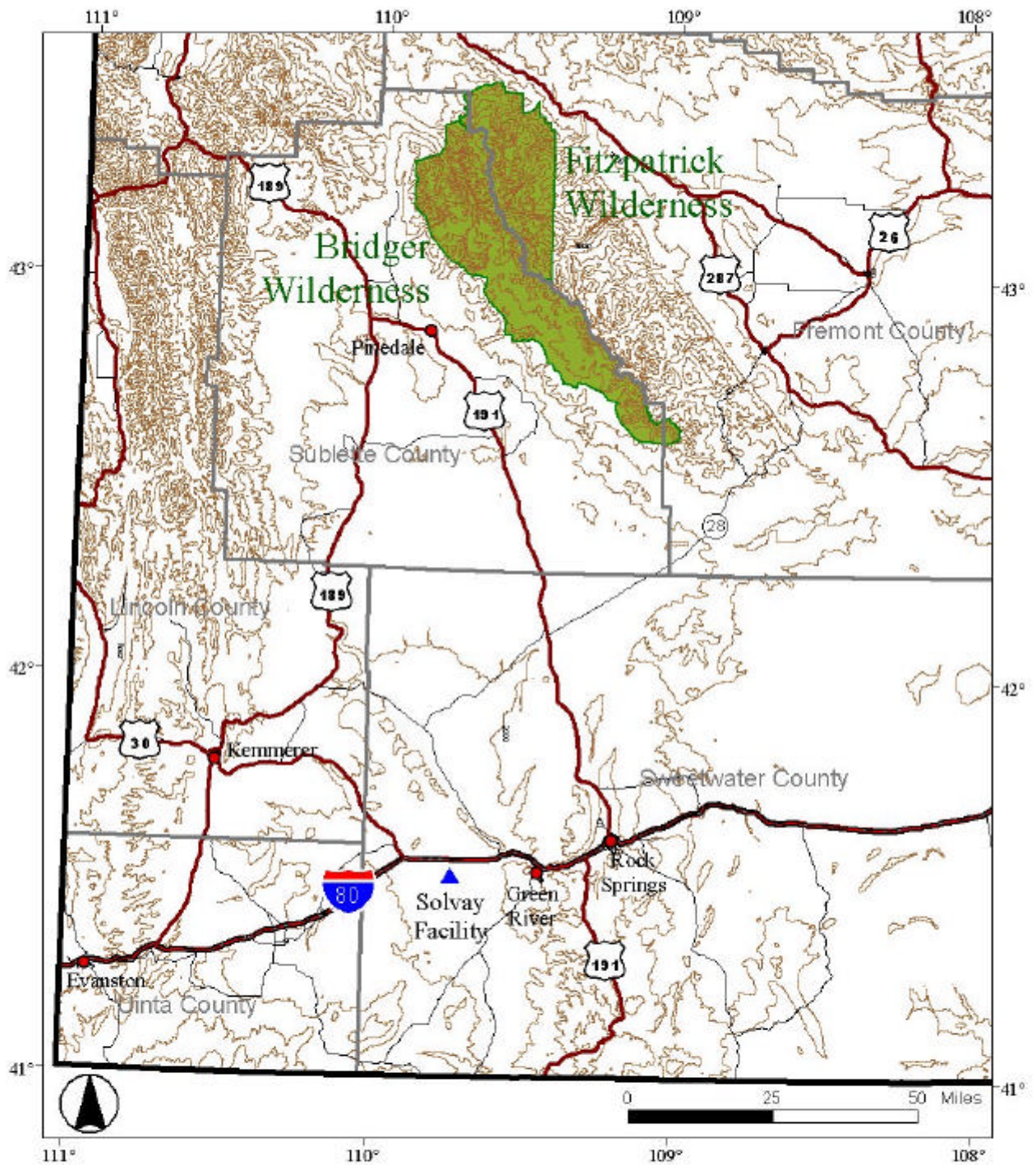
Figure 1.2: Westerly View of Solvay Facility

Combined Stack for Calciners A & B

FACILITY DESCRIPTION

The Solvay facility is an existing underground trona mine with surface processing facilities. The trona ore (sodium sesquicarbonate dihydrate [$Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$]) is processed into sodium-based products, including soda ash (sodium carbonate [Na_2CO_3]). Construction of the facility began in 1979, and it became operational in 1982. The air emission sources consist principally of calciners, dryers, boilers, and material handling processes. The facility is presently permitted under Wyoming Operating Permit No. 30-126 and has the potential to emit (PTE) of 405 tpy of particulate matter (PM_{10}); 619 tpy of sulfur dioxide (SO_2); 2,440 tpy of nitrogen oxides (NO_x); 2,464 tpy of volatile organic compounds (VOC); and 7,431 tpy of carbon monoxide (CO). There are four gas-fired calciners, two gas-fired dryers, two coal-fired boilers, and other smaller gas-fired combustion units. This application addresses a proposed change in the heat-generating furnaces associated with two of the calciners. Calciners are used to convert the trona ore to crude soda ash by driving off the carbon dioxide (CO_2) and water (H_2O). The equation is as follows:

$$2Na_2CO_3 \bullet NaHCO_3 \bullet 2H_2O \xrightarrow{\Delta} 3Na_2CO_3 + CO_2 + 5H_2O$$
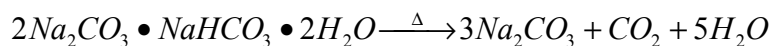
Solvay is proposing to convert the furnaces associated with Calciners A and B (Source #17) from natural gas-firing to coal-firing. Coal and trona particulate matter generated in the furnace and calciner will be controlled by an electrostatic precipitator (ESP) before being vented through a common stack. Stack parameters are provided in Table 2.1. There will be a calciner coal bunker for coal storage and handling with an associated baghouse to control particulate emissions. This source was deleted in the 1995 conversion from coal to gas-firing (MD-229), but will be refurbished and repermitted for this project. The stack parameters for this new source (Source #100) are provided in Table 2.2. From Table 2.1 it is apparent that with the shift to coal-firing, Source #17 will experience a twenty percent reduction in heat rate, but an increase in airflow, resulting in a substantial increase in airflow per unit of heat. The other stack parameters will remain the same. The potential to emit (PTE) and 2000/2001 actual emissions are shown in Table 2.3. The plant layout with the various buildings and all the facility emission points is shown on Figure 2.1, with Sources #17 and #100 specified.

With an increase in coal consumption related to Source #17, there could be an increase in the number of operating hours of existing coal-associated baghouses, resulting in an increase in actual emissions from Sources #10 (Coal Crusher) and #11 (Coal Transfer). These two sources had average actual PM_{10} emissions of 0.18 and 0.15 tpy for 2000 and 2001. Actual emissions will remain at or below the presently permitted PTEs of 1.14 and 0.92 tpy, respectively. Since these emission sources are not being modified, their actual emission increases are not addressed further.

Table 2.1: Modified Source #17 Physical Stack Parameters

Description	Present	Proposed
Height	180.5 ft	Unchanged
Heat Rate	500 MMBtu/hr	400 MMBtu/hr
Exit Diameter	12 ft	Unchanged
Exhaust Velocity	44 ft/sec	96 ft/sec
Exhaust Temperature	375°F	400°F
Flow Rate	312,000 ACFM	650,000 ACFM
Location	603,686 m (East)	Unchanged
	4,594,808 m (North)	Unchanged

Table 2.2: New Source #100 Physical Stack Parameters

Description	Proposed
Height	126 ft
Exit Diameter	1 ft
Exhaust Velocity	64 ft/sec
Exhaust Temperature	Ambient (68°F)
Flow Rate	3,000 ACFM
Location	603,681 m (East)
	4,594,817 m (North)

Table 2.3: Sources #17 and #100 Emission Rates in Tons per Year (tpy)

Column #1	Column #2	Column #3	Column #4	Column #5	Column #6	Column #7	Column #8
Pollutant	Source #	Present Actual Emissions*	Present Potential to Emit	Proposed Potential to Emit	PSD Review Threshold	Increase From Actual to Proposed PTE	PSD Review Triggered?
NO_x	17	49	131	788	40	739	yes
CO	17	1,077	6,675	5,533	100	4,456	yes
PM_{10}	17	32	98	180	15	148	yes
	100	0	0	1	15	1	
VOC (as ozone precursor)	17	1,199	3,399	2,714	40	1,515	yes

* Average of years 2000 and 2001.

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Figure 2.1: Solvay Facility Plant Layout and Emission Points
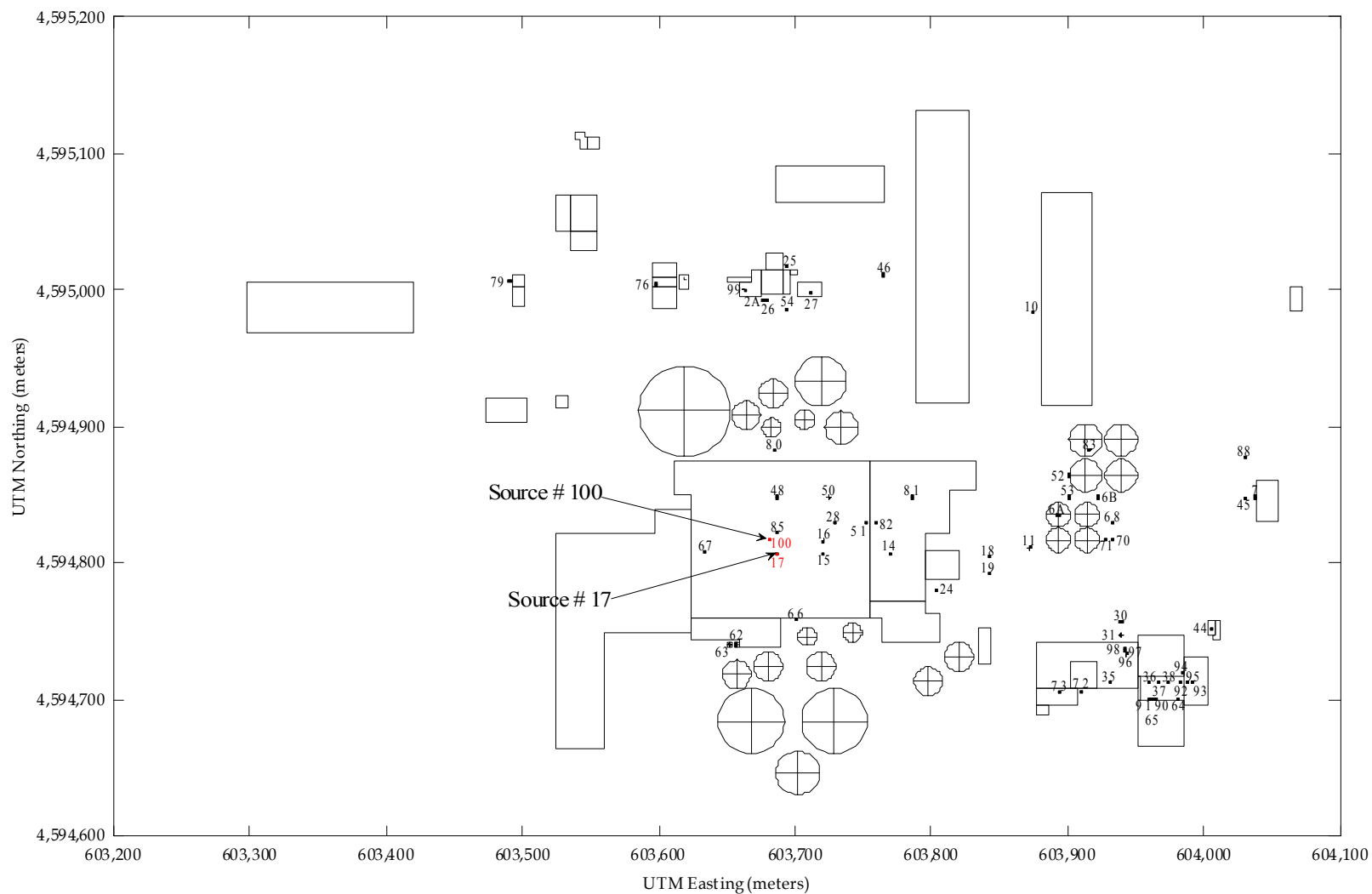
The 2000 and 2001 averaged actual emission rates and permitted potential to emit (PTE) for Source #17 are provided in Columns 3 and 4 of Table 2.3. The proposed PTEs under coal-firing of Sources #17 and #100 are listed in Column 5. For purposes of determining the triggering of "Major Modification" (Wyoming Air Regulations, Chapter 6, Section 4(a)(xii)), the "net emissions increase" is to be calculated. The net emissions increase is the difference between the proposed PTE and the present actual emissions. The review threshold amounts are listed in Column 6. The net emissions increase is provided in Column 7. From these increases it is apparent that NO_x, CO, PM_{10}, and VOC emissions are to be reviewed by the Major Modification review procedures.

Comparing present PTE (Column 4) with proposed PTE (Column 5), the increased NO_x emissions are due to an increase in the emission factor (mass of NO_x per unit of heat) of the coal burner. Although there will be sulfur in the coal, the trona ore will effectively absorb all of it during the calcination process. This has been previously demonstrated by stack tests when Source #17 was originally fired on coal. (Note that trona and soda ash are commonly used as SO_2 scrubbing agents.) There will be a minor increase in the coal burner's CO emission factor, offset by the decrease in trona feed rate and the CO emissions inherent in the trona calcination process. This results in the proposed PTE being less than the present PTE. There will be no change in the VOC emission factor, which is almost entirely a function of the trona feed rate (mass of VOC per unit of trona feed), but there will be a decrease in the VOC emissions because of a decrease in the trona feed rate, resulting in the proposed PTE being less than the present PTE. There will be no increase in the PM_{10} emission factor (mass of PM_{10} per unit of airflow through the electrostatic precipitator). However, since there will be an increase in airflow, there will be an increase in the mass of potential PM_{10} emissions.

SECTION 3

AREA DESIGNATION AND APPLICABLE REQUIREMENTS

The permitting process is described in the Wyoming Air Quality Standards and Regulations (WAQS&R) Chapter 6. Since southwest Wyoming is designated as an attainment area for all Wyoming Ambient Air Quality Standards (WAAQS), this permit modification need only address attainment regulations. In addition to the permitting requirements, New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP) requirements are also applicable. The applicable requirements are:

Chapter 5, Section 2: There is no applicable NSPS for Source #17. Subpart UUU addresses "Calciners and Dryers in the Mineral Industries," but soda ash is not included within the definition of such an industry (Subpart 60.731). Subpart Y – Standards of Performance for Coal Preparation Plants may be applicable to Source #100, which limits opacity to twenty percent (20%).

Chapter 5, Section 3 (NESHAPs): Neither Source #17 nor #100 is in a listed source category. Therefore, this section is not applicable.

Chapter 6, Section 2(a)(i): Solvay proposes to modify an existing facility, which may cause an increase in air contaminants. Thus, Solvay must obtain a construction permit.

Chapter 6, Section 2(b)(i): The application is to include plans, specifications, and the manner in which the sources are to be operated and controlled.

Baseline ambient monitoring may be required at the discretion of the Administrator. This proposed modification may result in a potential increase in NO_x and PM_{10} emissions. There will also be a present actual to future potential increase for CO and VOCs. Solvay previously monitored for NO_x and TSP, and is currently monitoring for PM_{10}. NO_x monitoring was discontinued in 1988 due to the low concentrations (average for 1987 was 5 $\mu g/m^3$). The on-site PM_{10} monitor has shown no exceedance of the Wyoming PM_{10} 24-hour or annual standards. Additional regional monitoring has been conducted for ozone through the Green River Basin Visibility Study and for CO at Riley Ridge. Solvay believes sufficient monitoring has been conducted to define a representative baseline for this application.

Chapter 6, Section 2(c)(ii): The application must demonstrate compliance with the WAAQS, as shown in Section 5 of this application.

Chapter 6, Section 2(c)(iii): The application must demonstrate compliance with PSD increments, as shown in Section 5 of this application.

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Chapter 6, Section 2(c)(v): The sources must utilize the Best Available Control Technology (BACT). A BACT analysis is found in Section 4 of this application.

Chapter 6, Section 2(c)(vi): The facility must have provisions for measuring the emissions of significant air contaminants as determined by the Administrator. These are already in place for the present configuration of Source #17, as described in the current Permit OP 30 - 126. The significant increase in NO_x will trigger the 40 CFR Part 64 Compliance Assurance Monitoring (CAM) requirements. The proposed methods to comply with CAM are described in Section 7 of this application.

Solvay is subject to Chapter 6, Section 3 (Major Source Operating Permits), and will submit a separate application for that purpose within 12 months after the Source #17 conversion, as required

To determine if the "Major Modification" permit review requirements are triggered per Chapter 6, Section 4(a)(x), Section 4(a) (xii) requires a calculation of the "net emissions increase." That is the difference between the present actual emissions and the proposed PTE. The net emissions increase is provided in Column 7 of Table 2.3, and illustrates that NO_x, CO, PM_{10}, and VOC emissions are to be reviewed by the Chapter 6, Section 4, Major Modification review procedures.

Chapter 6, Section 5: This regulation is not applicable because there are no Maximum Achievable Control Technology (MACT) standards for these sources.

Chapter 6, Section 6(h)(112 [g] MACT for Constructed and Reconstructed Major Sources): Source #17 is not being constructed or reconstructed per the definition of "applicability" in Section 6(h)(i) and because the new burner in and of itself will not emit 10 tpy of any hazardous air pollutant (HAP) or 25 tpy of any combination of HAPs per the definition of "reconstruction" in Section 6(f)(xii).

Chapter 6, Section 6(h)(iv) (112[j] case-by-case MACT): Source #17 is not a listed source within the October 16, 2002 updated list of proposed MACT Source Categories.

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PROPOSED CONTROLS - BACT

The potential emissions from coal combustion from Source #17 are presented in Table 2.3, Column 5, and the calculation is presented in Appendix A. There will be significant increases in the NO_x, CO, PM_{10}, and VOC emissions, which trigger a Best Available Control Technology (BACT) review for these four pollutants. The following BACT analysis considers control technologies outside the trona/soda ash industry because the industry is small and unique and there are insufficient recent process designs on which to base "current control practices." There are four mines with processing facilities operating in close proximity to each other in southwest Wyoming. There are two other facilities in the U.S. that produce soda ash, but they have a feedstock other than trona.

Solvay proposes to modify the furnaces that provide hot air to Calciners A and B (Source #17). The calciners will not be modified, so this BACT analysis only addresses the furnaces with their associated revised emissions. The industrial furnaces will be fueled by coal at a rate of 200 MMBtu/hr. These furnaces are different from boilers with regard to the combustion kinetics and NO_x formation. A boiler contains heater tubes that extract heat as the combustion air flows down the boiler. By removing the heat quickly, the temperature is reduced, thereby suppressing thermal NO_x production. These furnaces are also unlike those associated with cement, lime, kaolin kilns, or diatomaceous earth calciners. In those applications, combustion takes place within the calciner. The purpose of the industrial furnaces associated with the trona calciners is to supply hot air for calcination of the trona ore to soda ash. This is a unique process.

The BACT process is described in the "Puzzle Book" (New Source Review Workshop Manual, Draft, October 1990, U. S. EPA, Chapter B). The process consists of five distinct steps for the purpose of determining BACT. These steps are:

- Identify all available control technologies.
- Eliminate technically infeasible options.
- Rank remaining control technologies by control effectiveness.
- Evaluate most effective controls and document costs.
- Select BACT.

4.1 BACT Review - NO_x Emissions

The BACT review process described above is applied to the NO_x emission controls for the Solvay industrial furnaces in this subsection.

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4.1.1 Identify all Available NO$_x$ Combustion Control Technologies

AP-42 Section 8.12 addresses the Sodium Carbonate industry, but in that section there is no discussion of combustion emissions and controls. That section refers to Chapter 11, Mineral Products Industry, for more specific emissions information. In fact, AP-42, Chapter 1, Section 1, "Bituminous and Subbituminous Coal Combustion," comes closest of all AP-42 sections to addressing the NO$_x$ control methods available to Solvay for these furnaces; however, this section is directed almost entirely to boilers. The list of NO$_x$ control options from this section is given below. Section 11.17, Lime Manufacturing; Section 11.3, Brick and Related Clay Products; and Section 11.6, Portland Cement Manufacturing, also discuss NO$_x$ controls and add the "preheater" as an option to those listed in Chapter 1, Section 1. The range of the NO$_x$ control options derived from these AP-42 sections is as follows:

- Operational Modifications (rearrangement of air and fuel for good engineering design [GED])
- Over-Fire Air (OFA)
- Low-NO$_x$ Burners (LNB)
- Reburn
- Selective Non-Catalytic Reduction (SNCR)
- Selective Catalytic Reduction (SCR)
- Preheaters

Solvay's engineers add the following two possible control technologies:

- Flue Gas Recirculation (FGR)
- Water Injection (WI)

A search of the RACT BACT LAER Clearinghouse (RBLC) for other possible NO$_x$ control technologies applied to coal-fueled devices other than boilers (e.g., furnaces, incinerators, kilns, dryers) yields the information in Table 4.1.

Table 4.1: Installed NO$_x$ Control Technologies Listed in the RBLC for Coal-Fueled Devices Other Than Boilers

Control Technology	Number of Cases in the Clearinghouse
No control	15
Careful combustion control	18
Low-NO$_x$ combustors	9
Urea spray into preheater combustion zone – SNCR	2
Conversion to add a pre-calciner (preheater)	3
Steam injection, alkaline stream in venturi scrubber	1
Kiln afterburner	1
Wet scrubbers	2
Baghouse	2

The California Air Resources Board Control Technology database contributed two additional sources. Both determinations were for cement plants, and both employed pre-calciners and good combustion practices.

From these tables, wet scrubbers, baghouses, and steam injection into the venturi scrubber are discounted, since they are actually controls for particulates. It is concluded that there are no additional NO$_x$ technologies to add to the AP-42 and Solvay Engineers list.

4.1.2 Eliminate Technologically Infeasible Technologies

There are two fundamentally different types of coal-fueled furnaces that could satisfy the Solvay calciner needs, pulverized coal (PC) and stoker coal (SC). Both are limited in size by the volume available in front of the calciner and limited in slagging characteristics to a buildup rate that will not substantially disrupt operations. The location restriction is forced by the need to be near the calciner inlet to maintain a high input air temperature, and to be near the flue gas for NO$_x$ control purposes (as explained later in this section).

Regardless of the furnace type, SCR is infeasible because the temperatures of the exhaust gases at the exit of the calciner are 300°F to 400°F, which is well below the 700°F minimum temperature needed for the SCR reaction.

A furnace, unlike a boiler, has no heat extraction as gases pass down the furnace. Because of that, low NO$_x$ burners (LNB) for furnaces are ruled out as a technically feasible control technology, as described in AP-42 (page 1.1-9) in the following statement:

> *LNBs are applicable to tangential and wall-fired boilers of various sizes but are not applicable to other boiler types such as cyclone furnaces or stokers.*

Preheaters are devices unique to cement and lime kilns. They are technologically infeasible as there is insufficient waste heat in the Solvay calciner circuit to provide pre-heating to the feedstock.

Reburn is a control technology that requires injection of natural gas downstream of the coal combustion and is applicable only in very specific boiler configurations, different from the Solvay furnaces. It is technologically infeasible for Solvay's application.

The remaining NO_x control possibilities are GED, OFA, SNCR, FGR, and WI as possibly being technologically feasible.

Solvay retained an expert coal combustion specialty firm (Reaction Engineering, Salt Lake City) to assist in the design and selection of the furnace technologies. Reaction Engineering requested bids for the two alternative furnace types, PC and SC, with emphasis on the need for low-NO_x emissions. The results are as follows:

PC Furnace Design

The combustion engineering consultant performed a survey of the market for current designs that could meet heat input requirements, space limitation criteria, and provide low-NO_x emissions. The results from the search for the PC-fired designs are attached in Appendix B. The conclusion is that most manufacturers do not have, nor are they interested in developing a furnace for Solvay's needs that would have NO_x emissions any lower than the 0.7 lb/MMBtu of the original Solvay furnace.

One manufacturer offered a theoretical design (listed under Black & Veatch/Damper Design) that could meet 0.35 lb NO_x/MMBtu under the special requirements of an additional gas-fired inlet air duct heater (10 MMBtu/hr) and micronized coal injection, both of which are relatively untested, and not tested for Solvay's specific requirements. Moreover, this special furnace would require the use of natural gas with the coal for proper operation. This special furnace would be considered, at best, as available through technology transfer. However, it has not been shown in any full-scale operation to provide the required service to the calciner. In other words, there is no demonstration that it can actually do the job reliably (operation without system breakdowns and unacceptable slag buildup, shown to occur in previous PC furnace testing for Solvay) for which it is being considered. Thus, in line with the EPA guidance Puzzle Book, Chapter B, IV, A, 1, "technologies which have not yet been applied to full-scale operations need not be considered available; an applicant should be able to purchase or construct a process that has already been demonstrated in practice." Solvay considers this special design to not be a "commercially available" process unit.

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SC Furnace Design

Detroit Stoker Company provided a bid for an SC furnace with low-NO_x emissions. In their design they experimented with four of the remaining process modifications for NO_x control not yet eliminated as technologically feasible control technologies, incorporating GED and OFA in all designs. The results of the combustion modeling with these control options are shown in Table 4.2. Prior to converting the coal-fired calciners to gas in 1995, the NO_x emission rate was 0.7 lb/MMBtu with a stoker-coal system. The original OFA configuration has been revised to increase energy efficiency, and results in a modeled emission rate of 0.79 lb NO_x/MMBtu. Water injection into the furnace could reduce that emission rate to 0.5 lb NO_x/MMBtu. By recirculating 30% of the flue gases, the emission rate could be reduced to 0.42 lb NO_x/MMBtu.

These emission rates were estimated by a Computational Fluid Dynamic (CFD) model and have not been demonstrated in a commercial furnace. However, utilizing GED, OFA, FGR, and retaining the option to also use WI if necessary, Detroit Stoker Company has guaranteed an emission rate of 0.45 lb NO_x/MMBtu. As is common in reducing NO_x emissions, there is a trade-off with increased CO emissions. The CO and NO_x emissions are detailed in the table below with the revised OFA and addition of WI and FGR.

Table 4.2: NO_x Emissions for Various Combinations of Controls Built Into the Furnace Design

	Original OFA Config. (1980)	Revised OFA Config.	WI + Revised OFA Config.	FGR + Revised OFA Config.
Exit CO (ppm)	34	25	22	522
Exit NO_x (lb/MMBtu)	0.70	0.79	0.50	0.42
Exit NO_x (ppm)	278	308	194	161

SNCR is an add-on control technology that, to the knowledge of Detroit Stoker (letter is included in Appendix B), has not been applied to similar applications of SC furnaces. It has not been installed in a furnace associated with a trona calciner, and there is no prior application to furnaces listed in the RBLC. To determine if SNCR could be a feasible technology would require research and testing. The method for injecting ammonia would need to be determined as well as the adequacy of the mixing and residence time downstream of the combustion zone for reducing NO_x. Therefore, Solvay considers SNCR to not be commercially available for its furnace application.

Although the Solvay furnaces are unlike other coal-fueled source categories, a statistical summary of the NO_x emission factors for all facilities other than boilers from the RACT BACT LAER Clearinghouse (RBLC, 1993 - 2002) is provided in Table 4.3 for comparison. To generate Table 4.3, an assumption was made for some of the lime and cement kilns that an average thermal efficiency of 5.5 MMBtu heat input was required per ton of product in order to convert all emissions to the units of mass NO_x per MMBtu heat input. By comparing the proposed

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Solvay furnace NO_x emission rate of 0.45 lb/MMBtu to the rates found in Table 4.3, it is found to be below the average for all four categories and below or near the minimums.

Table 4.3: Pounds of NO_x per MMBtu From Coal-Fueled Devices Other Than Boilers

Process	Count	Average	Min.	Max.	Range
Cement	10	1.26	0.43	3.40	2.97
Lime	6	0.53	0.37	0.64	0.27
Coal dryer	5	0.55	0.43	0.80	0.37
Refractory	2	6.55	6.18	6.91	0.73

4.1.3 Selection of BACT for NO_x

Solvay asserts that the available and feasible technology with the lowest NO_x emission rate for the calciner furnaces is the Detroit Stoker design at 0.45 lb/MMBtu. Since Solvay is committing to the installation of the lowest-emitting technology, it represents BACT for NO_x emissions, and there is no need to discuss costs.

4.2 BACT Review - PM Emissions

Source #17 presently has electrostatic precipitators (ESP) installed as the particulate control. With the high quantity of airflow from trona calciners, ESPs are considered BACT.

Particulate emissions associated with Source #100 will be controlled with a baghouse to 0.01 gr/dscf. This is widely accepted as BACT for a material-handling source of this type.

4.3 BACT Review - VOC and CO Emissions

A BACT analysis was prepared for VOC and CO emissions in the CT - 1347 (February 6, 1998) permit application. The cost data provided in that analysis is still current. Since the air flow rates will be increased per unit of throughput, these costs will increase for the scenario of stoker coal combustion. Thus, that analysis is sufficient for the VOC BACT analysis. There will be no VOC control, and the CO control will consist of good combustion control with the maintenance procedures described in Appendix B of OP 30 - 126.

SECTION 5

ENVIRONMENTAL EVALUATION - CLASS II AREAS

The proposed furnace conversion is associated with a significant increase in NO_x, CO, PM_{10}, and VOC emissions. As required by the Wyoming permitting rules, the impacts of these four pollutants must be estimated for the areas surrounding the facility, which are Class II areas. The first three pollutant impacts are estimated using the Industrial Source Complex Short Term (ISCST3) Dispersion Model and five years (1987 to 1991) of Rock Springs meteorological data. The ozone (O_3) impacts, expressed in terms of VOC and NO_x emissions, are estimated using Scheffe's screening tables. The methodology for these analyses is based on the modeling protocol (dated December 2002) and on the subsequent response to the Wyoming DEQ questions (dated February 3, 2003). The Wyoming DEQ requested a full PM_{10} increment consumption analysis with previous permit applications; therefore, although not required, the full analysis was again conducted. A screening risk assessment addressing the impacts of the Hazardous Air Pollutants (HAPs) from coal-firing is also included and is based on the above long-term ISCST3 emission-to-impact ratios. Each of these analyses is discussed briefly in the following sections.

5.1 Dispersion Modeling for NO_x, PM_{10}, and CO

The preliminary step in the impact analysis is to determine for each pollutant whether the impacts from the net emission increases from the project (Table 2.3, Column 7) are less than the applicable Significant Impact Levels (SILs). If the impacts are less than the SILs, then no actual impact analysis is required. However, if the impacts are significant, then a full analysis is needed.

Results of the preliminary analysis are summarized in Table 5.1. The source locations, property boundary, and locations of the maximum impacts (from Table 5.1) are presented in Figure 5.1. This figure shows that all of the maximum impacts occur on or near the property boundary line, and Table 5.1 shows that impacts of the three pollutants are below their respective SILs for all averaging periods. Thus, no further Class II impact analyses are required for these pollutants.

Table 5.1: Estimated Maximum Impacts Compared With SILs

Pollutant	Averaging Period	Maximum Impact ($\mu g/m^3$)	Location Easting (m)	Location Northing (m)	Year	SIL ($\mu g/m^3$)
NO_x	Annual	0.6	604,400	4,594,900	1988	1.0
PM_{10}	Annual	0.2	604,400	4,594,900	1988	1.0
	24-Hour	2.8	603,000	4,594,000	1991	5.0
CO	8-Hour	161.0	603,000	4,594,000	1991	500.0
	1-Hour	363.7	602,600	4,593,700	1989	2,000.0

Figure 5.1: Maximum Impacts from Proposed Emission Increases from Source # 17 and # 100

SOLVAY2016_1.3_000322
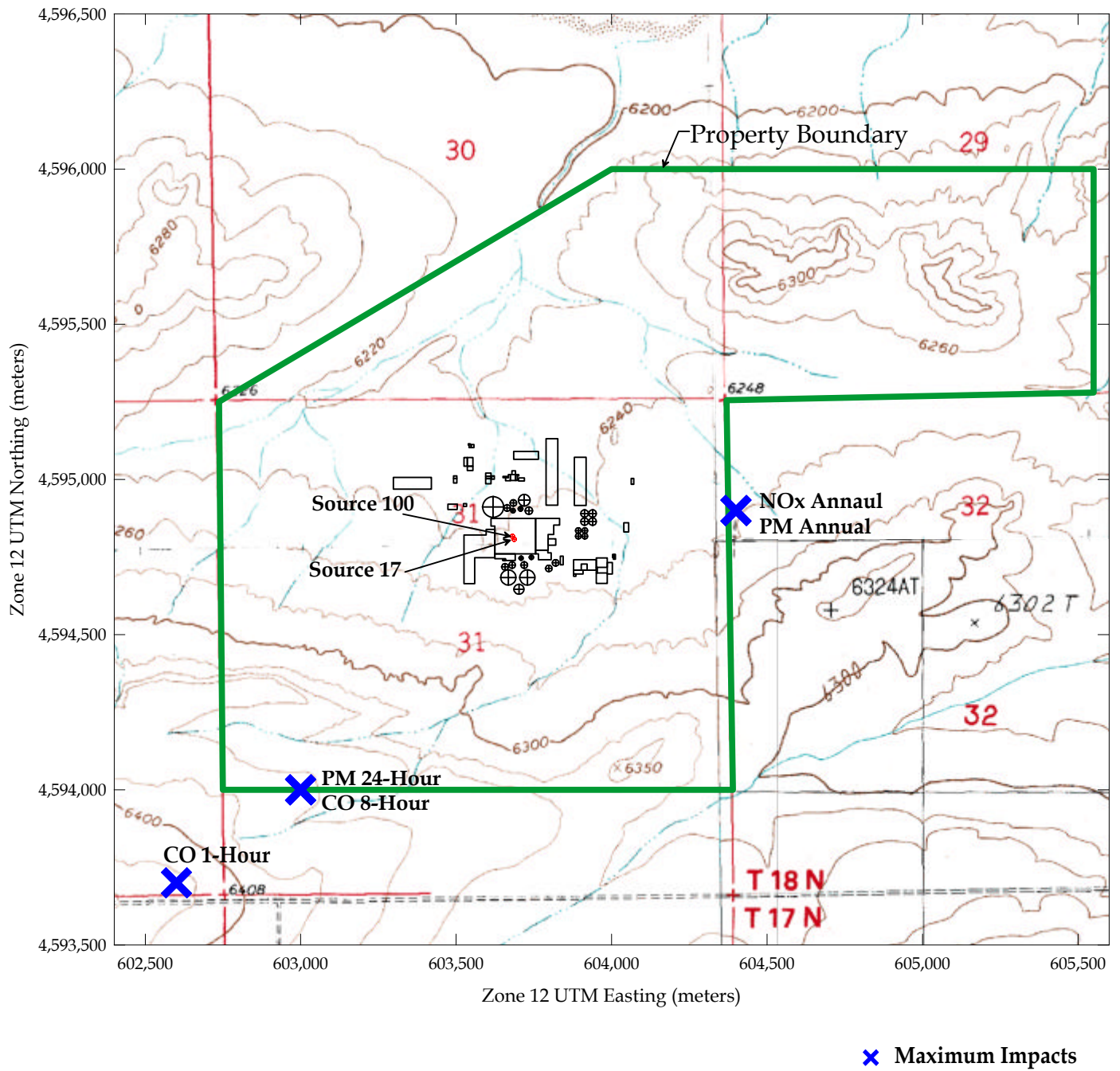
The ISCST3 and BPIP model input and output files, meteorological data files, DEM files, and other related documentation are provided on the attached compact disk.

5.2 O_3 Evaluation

There is no SIL for O_3, so the O_3 impacts are estimated and compared with the applicable WAAQS. The O_3 impact analysis uses Scheffe's screening tables (VOC/NO_x Point Source Screening Tables, 1988). The procedure and calculations for O_3 estimation and applicable rural screening table are presented in Appendix C on Sheets C.1 and C.2. The maximum predicted O_3 concentration from Scheffe's screening table, the O_3 background concentration, and the applicable Wyoming O_3 standard are shown in Table 5.2.

Table 5.2: Estimated O_3 Concentration Compared With WAAQS

Averaging Period	Estimated Concentration (μg/m^3)	Background Concentration (μg/m^3)	Maximum Predicted Concentration (μg/m^3)	WAAQS (μg/m^3)
1-hour	66.1	161.0	227.1	235

Table 5.2 shows that the maximum predicted O_3 impact from Solvay's VOC emissions is expected to be below the O_3 WAAQS. The Background Concentration is from the Green River Basin Visibility Study (GRBVS).

5.3 Full PM_{10} PSD Increment Consumption Analysis

Although not required by the Wyoming DEQ, Solvay also conducted a PM_{10} increment consumption analysis to demonstrate compliance with the PM_{10} Class II PSD increment standards. The methods were the same, except for the modified PM_{10} emissions, as a previously conducted analysis (*Solvay Minerals Inc., Particulate Matter Impact Analysis Trona Products Expansion, April 2002*). This analysis also includes PM_{10} increment-consuming emissions from the two nearby facilities (FMC – Westvaco and General Chemical) as recommended by the Wyoming DEQ for the previous analysis.

The Solvay facility-wide and the nearby increment-consuming sources, their PM_{10} emission rates, and other modeling parameters are listed in Table 5.3. Again, five years (1987 to 1991) of Rock Springs meteorological data were used. The modeling methodology and the assumptions made are the same as in the previous analysis. Further details about the assumptions, the applied methodologies, and data sets used, are provided in the previous report.

The digital modeling files and a copy of the previous analysis report are provided on the attached compact disk.

Table 5.3: Modeled Stack Parameters

Emission Point ID	UTM X (m)	UTM Y (m)	Base Elevation (m)	PM₁₀ Emission Rate (lb/hr)	PM₁₀ Emission Rate (g/s)	Stack Height (ft)	Stack Height (m)	Exit Temperature (°K)	Exit Velocity (m/s)	Exit Diameter (m)
Existing Solvay Minerals Emissions Points										
2A	603677	4594992	1900	1.59	0.20	23	7.01	293	15.85	1.06
6A	603893	4594835	1903	0.32	0.04	133	40.54	309	24.99	0.64
6B	603922	4594848	1903	0.48	0.06	15	4.72	297	10.06	0.67
7	604037	4594848	1906	1.19	0.15	82	24.99	293	19.51	0.75
10	603874	4594983	1900	0.24	0.03	13	4.05	293	5.49	0.60
11	603872	4594811	1901	0.24	0.03	35	10.76	293	6.40	0.55
14	603770	4594807	1902	0.40	0.05	125	38.10	293	17.37	0.43
15	603721	4594807	1902	4.36	0.55	180	54.86	347	14.94	1.83
16	603721	4594816	1902	0.87	0.11	126	38.40	369	12.80	1.07
18	603842	4594804	1902	5.00	0.63	180	54.86	325	17.68	2.21
19	603842	4594792	1902	5.00	0.63	180	54.86	322	18.29	2.21
24	603804	4594780	1902	0.32	0.04	25	7.62	302	12.50	0.30
25	603694	4595017	1900	1.03	0.13	76	23.16	293	14.63	0.73
26	603679	4594992	1900	0.56	0.07	67	20.42	311	17.68	0.73
27	603712	4594998	1900	0.48	0.06	60	18.29	293	18.90	0.48
28	603729	4594829	1902	2.93	0.37	140	42.67	347	12.19	1.22
30	603939	4594757	1902	0.24	0.03	88	26.82	293	17.98	0.20
31	603939	4594747	1902	0.24	0.03	88	26.82	293	17.98	0.20
35	603931	4594712	1905	1.43	0.18	103	31.39	327	14.63	0.70
36	603960	4594712	1905	0.08	0.01	60	18.29	338	25.88	0.15

Table 5.3: Modeled Stack Parameters (continued)

Emission Point ID	UTM X (m)	UTM Y (m)	Base Elevation (m)	PM$_{10}$ Emission Rate (lb/hr)	(g/s)	Stack Height (ft)	(m)	Exit Temperature (^{o}K)	Exit Velocity (m/s)	Exit Diameter (m)
37	603967	4594712	1905	0.08	0.01	60	18.29	338	25.88	0.15
38	603974	4594712	1905	0.08	0.01	60	18.29	338	25.88	0.15
44	604005	4594752	1905	0.16	0.02	63	19.20	293	17.07	0.30
45	604030	4594847	1906	0.24	0.03	18	5.43	293	8.84	0.27
46	603765	4595011	1900	0.71	0.09	13	3.81	293	14.02	0.67
48	603687	4594848	1902	9.28	1.17	180	54.86	450	9.75	3.20
50	603725	4594848	1902	0.71	0.09	180	54.86	366	8.23	1.37
51	603752	4594829	1902	2.38	0.30	180	54.86	422	10.06	2.44
52	603901	4594864	1903	0.48	0.06	141	42.98	293	15.24	0.46
53	603901	4594848	1903	0.48	0.06	30	9.14	293	10.97	0.85
54	603694	4594986	1900	0.16	0.02	64	19.57	293	24.08	0.18
62	603657	4594740	1900	0.16	0.02	91	27.74	293	33.53	0.15
63	603652	4594740	1900	0.16	0.02	58	17.68	293	35.66	0.15
64	603981	4594700	1905	0.08	0.01	29	8.84	293	29.26	0.15
65	603962	4594700	1905	0.08	0.01	8	2.44	293	11.58	0.23
66	603701	4594758	1902	0.56	0.07	20	6.10	293	22.86	0.30
67	603634	4594808	1902	0.48	0.06	125	38.10	311	10.06	0.46
68	603933	4594829	1905	0.40	0.05	82	24.99	293	23.47	0.37
70	603933	4594817	1905	0.24	0.03	82	24.99	293	14.94	0.40
71	603928	4594817	1905	0.24	0.03	82	24.99	293	14.94	0.40
72	603910	4594706	1905	0.08	0.01	61	18.49	366	16.15	0.20

Table 5.3: Modeled Stack Parameters (continued)

Emission Point ID	UTM X (m)	UTM Y (m)	Base Elevation (m)	PM$_{10}$ Emission Rate (lb/hr)	PM$_{10}$ Emission Rate (g/s)	Stack Height (ft)	Stack Height (m)	Exit Temperature (°K)	Exit Velocity (m/s)	Exit Diameter (m)
73	603894	4594705	1905	0.87	0.11	95	28.96	305	17.07	0.61
76	603598	4595004	1900	2.46	0.31	110	33.53	293	17.22	1.12
79	603491	4595006	1900	0.87	0.11	68	20.73	293	18.26	0.63
80	603685	4594882	1902	12.21	1.54	180	54.86	425	15.49	3.20
81	603786	4594848	1902	0.48	0.06	120	36.58	394	23.29	0.51
82	603760	4594829	1902	3.41	0.43	180	54.86	421	13.15	2.44
83	603916	4594883	1903	0.40	0.05	130	39.62	366	17.47	0.51
85	603687	4594822	1902	0.48	0.06	140	42.67	436	15.24	0.91
88	604030	4594877	1906	0.24	0.03	11	3.35	293	19.51	0.30
90	603965	4594700	1905	0.08	0.01	23	7.01	293	19.20	0.15
91	603960	4594700	1905	0.08	0.01	24	7.32	293	19.20	0.15
92	603983	4594712	1905	0.32	0.04	64	19.51	293	25.91	0.32
93	603992	4594712	1905	0.16	0.02	70	21.34	293	16.15	0.30
94	603984	4594719	1905	0.32	0.04	90	27.43	293	25.91	0.32
95	603988	4594712	1905	0.08	0.01	90	27.43	293	25.91	0.15
96	603943	4594733	1905	0.16	0.02	82	25.00	293	21.94	0.25
97	603942	4594735	1905	0.10	0.01	82	25.00	293	21.94	0.20
98	603942	4594737	1905	0.40	0.05	82	25.00	293	17.07	0.46
99	603663	4595000	1900	3.24	0.41	125	38.10	293	15.24	1.37
Modified Source #17 and New Source #100										
17	603687	4594807	1902	41.1	5.18	180	54.86	477.6	29.15	3.66
100	603681	4594817	1902	0.2	0.02	126	38.4	293	19.4	0.3

Table 5.3: Modeled Stack Parameters (continued)

Emission Point ID	UTM X (m)	UTM Y (m)	Base Elevation (m)	PM$_{10}$ Emission Rate (lb/hr)	(g/s)	Stack Height (ft)	(m)	Exit Temperature (^{o}K)	Exit Velocity (m/s)	Exit Diameter (m)
Nearby Increment-Consuming Sources from FMC-Westvaco										
BC1	599153	4608435	1896	3.01	0.38	93	28.35	350	18.63	0.76
BC2	599153	4608484	1896	1.67	0.21	91	27.74	313	10.35	0.76
MONO11	599323	4607941	1896	3.01	0.38	25	7.62	291	20.70	0.76
MONO12	599331	4608374	1896	1.74	0.22	60	18.29	294	17.25	0.91
MW3	599058	4608059	1896	0.24	0.03	130	39.62	339	18.38	1.98
RA29	598812	4608511	1896	0.32	0.04	80	24.38	355	29.51	1.22
Nearby Increment-Consuming Sources from General Chemical										
FD617	603742	4605237	1902	0.24	0.03	4	1.22	286	26.73	0.20
GR3Q	603476	4605127	1902	1.51	0.19	118	35.96	341	13.44	0.91

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Table 5.4 shows the modeled maximum annual and the 24-hour highest second-highest (H2H) (on an annual basis from the five years of analysis) PM_{10} concentrations as a result of Solvay and the nearby sources' increment-consuming emissions. The maximum impacts occur on the property line directly to the east of the plant. Both the maximum annual (9.3 µg/m³) and H2H 24-hour (29.1 µg/m³) concentrations are less than the applicable Class II PSD increments.

Table 5.4: Maximum Predicted PM_{10} Impacts Compared With PSD Increments

Averaging Time	Maximum Predicted Impacts (µg/m³)	Date	Receptor Location		Class II PSD Increment (µg/m³)
			Easting (m)	Northing (m)	
24-hour H2H	29.1	12/26/87	604,400	4,594,850	30
Maximum annual	9.3	1988	604,400	4,594,950	17

Figures 5.2 and 5.3 show the contours of the maximum annual and 24-hour concentrations around the facility. The locations of the two nearby facilities and the receptor grids used in this analysis are also presented. These figures show that the highest impacts are on the property line east of the facility and decrease with distance from the facility.

Figure 5.2: Maximum Annual PM$_{10}$ Impacts

Contour Units in μg/m³

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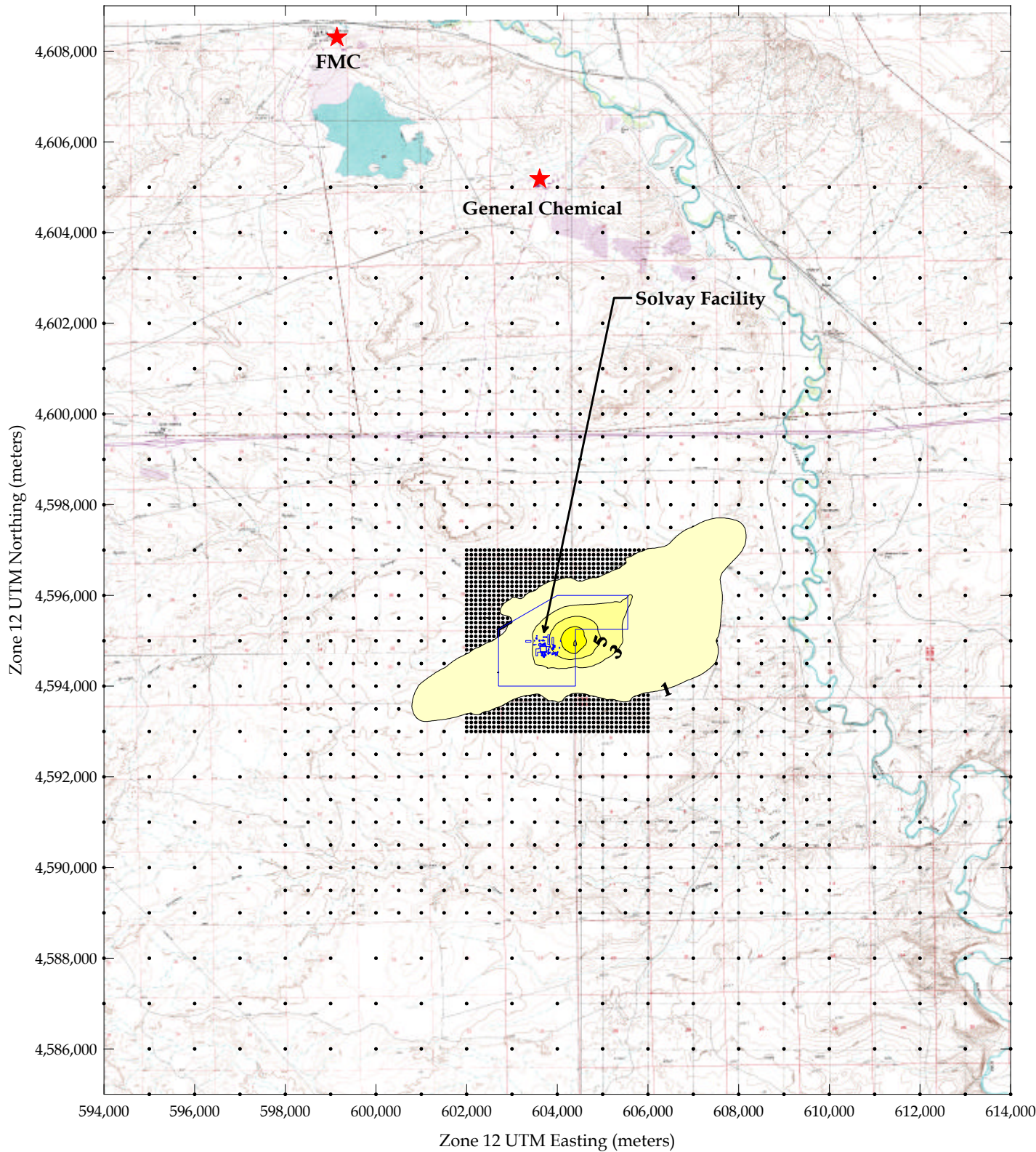
Figure 5.3: Maximum 24-Hour PM$_{10}$ Impacts

Contour Units in μg/m³

SOLVAY2016_1.3_000330

5.4 Hazardous Air Pollutants Impact and Risk Assessment

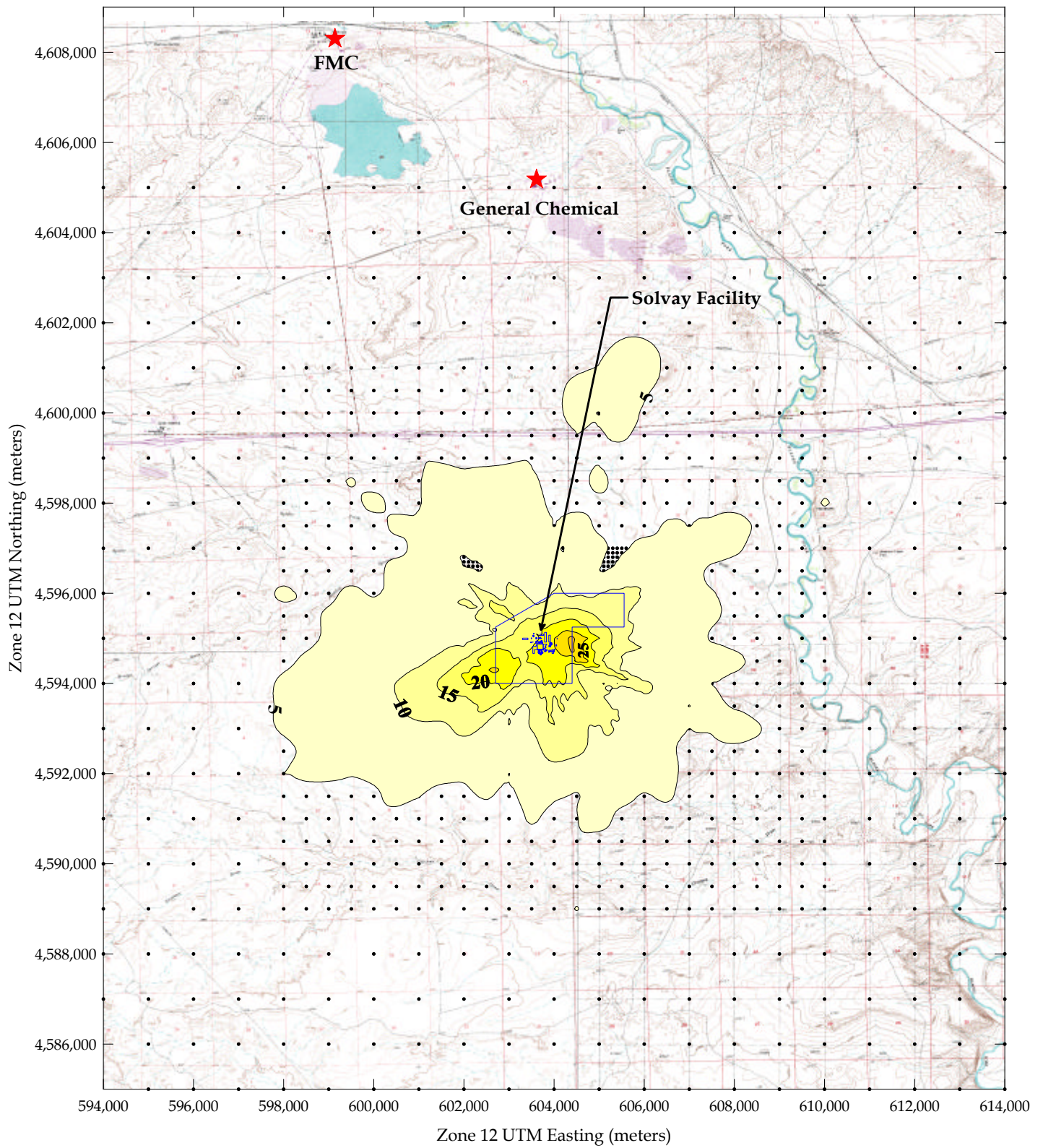An ambient impact assessment was performed to assess chronic human health impacts and cancer risks associated with hazardous air pollutants (HAPs) released from Source #17 (Source #100 HAP emissions are negligible and therefore not considered). Emission rates for a list of HAPs were estimated using the AP-42 emission factors (Tables 1.1-14 and 1.1-18). These HAPs were selected on the basis of their toxicity and known adverse human health effects. The selected HAPs, their EPA toxicity classification, AP-42 emission factors, and estimated emission rates are provided in Table 5.5. These emission factors are representative of the effluent downstream of boilers utilizing an Electrostatic Precipitator (ESP), which are assumed to be similar to the effluent downstream of the ESP on the Solvay furnace.

Table 5.5: Hazardous Air Pollutants Emissions and EPA Classification

HAP	EPA Classification [a]	AP-42 Emission Factor (lb/ton – coal)	Estimated Emission (lb/hr)[b]	(g/sec)
Arsenic	Group A	4.1×10^{-4}	8.1×10^{-3}	1.0×10^{-3}
Benzene	Group A	1.3×10^{-3}	2.6×10^{-2}	3.2×10^{-3}
Beryllium	Group B	2.1×10^{-5}	4.1×10^{-4}	5.2×10^{-5}
Ethylbenzene	Group D	9.4×10^{-5}	1.9×10^{-3}	2.3×10^{-4}
Formaldehyde	Group B	2.4×10^{-4}	4.7×10^{-3}	6.0×10^{-4}
Hexane	Group D	6.7×10^{-5}	1.3×10^{-3}	1.7×10^{-4}
Mercury	Group D	8.3×10^{-5}	1.6×10^{-3}	2.1×10^{-4}
Toluene	Group D	2.4×10^{-4}	4.7×10^{-3}	6.0×10^{-4}
Xylenes	Group D	3.7×10^{-5}	7.3×10^{-4}	9.2×10^{-5}

[a] Group A – Human Carcinogen
  Group B – Probable Human Carcinogen
  Group D – Not Classifiable as to Human Carcinogenicity
[b] Based on a coal consumption rate of 19.7 ton/hr

The maximum annual impact for each of the above HAPs was estimated using the ratio of maximum annual NO_x impact ($\mu g/m^3$) to NO_x emission rate (g/sec) as follows:

$$C_{Ti} = Q_{Ti} \times \frac{C_{NOx}}{Q_{NOx}}$$

where:

C_{Ti} is concentration for toxin i ($\mu g/m^3$)

C_{NOx} is NO_x concentration ($\mu g/m^3$)

Q_{Ti} is emission rate for toxin i (g/sec)

Q_{NOx} is NO_x emission rate (g/sec)

The estimated maximum HAP impacts were compared with their respective chronic effect thresholds. In the case of known or probable carcinogens, where the cancer risk factors are available, the estimated maximum impacts were divided by their respective one-in-a-million risk factors to estimate the cancer risks associated with the HAP emissions based on a lifetime exposure. The impacts and the applicable chronic exposure thresholds and cancer risks are provided in Table 5.6. This table also lists the sources of the chronic exposure thresholds and cancer risk factors. Detailed calculations are provided in Appendix C on Sheet C.3.

As shown in Table 5.6, the estimated impacts were below the respective chronic effect thresholds for all of the listed HAPs. Therefore, none of these HAP releases from Source #17 pose a significant human health threat. Table 5.6 also shows that all of the estimated cancer risks are below the EPA acceptable one-in-a-million risk. Furthermore, the cumulative risk from Table 5.6 is 1.6×10^{-7}, which is also less than the EPA acceptable risk level.

Table 5.6: HAP Impacts Compared With Chronic Exposure Thresholds and Cancer Risk Factors

HAP	Estimated Maximum Impact ($\mu g/m^3$)	Chronic Exposure Threshold [d, e, f] ($\mu g/m^3$)	One-in-a-Million Cancer Risk Factor [c] ($\mu g/m^3$)	Source	Cancer Risk	Chronic Exposure Exceeded (Yes/No)
Arsenic	3.0×10^{-5}	5.0×10^{-2}	2.0×10^{-4}	IRIS	1.5×10^{-7}	No
Benzene	9.6×10^{-5}	60.0	0.13 to 0.45	CalEPA	7.4×10^{-10}	No
Beryllium	1.6×10^{-6}	2.0×10^{-2}	4.0×10^{-4}	IRIS	3.9×10^{-9}	No
Ethylbenzene	7.0×10^{-6}	1000.0	N/A	IRIS	N/A	No
Formaldehyde	1.8×10^{-5}	4.0	8.0×10^{-2}	ATSDR	2.2×10^{-10}	No
Hexane	5.0×10^{-6}	200.0	N/A	IRIS	N/A	No
Mercury	6.1×10^{-6}	3.0×10^{-1}	N/A	IRIS	N/A	No
Toluene	1.8×10^{-5}	400.0	N/A	IRIS	N/A	No
Xylenes	2.7×10^{-6}	400.0	N/A	ATSDR	N/A	No

[c] EPA Air Toxics Website (http://www.epa.gov/ttn/atw/hapindex.html) and IRIS

[d] EPA Integrated Risk Information System (IRIS), Reference Concentration (RfC)

[e] California EPA (CalEPA), Chronic Reference Exposure Level

[f] Agency for Toxic Substances and Disease Registry (ATSDR) , Chronic Inhalation Minimal Risk Level (MRL)

CLASS I MODELING

6.1 Impact Thresholds

The Wyoming Chapter 6 Permitting Requirements, Section 2(c)(iii), require that impacts of any proposed facility not cause an exceedance of the Class I area increments. These increments are provided in Table 6.1. Moreover, the EPA has proposed (FR July 23, 1996, pp. 38,249 – 38,344) to allow for a demonstration of "insignificant impact," which exempts a proposed facility from performing a full increment consumption analysis (Wyoming DEQ follows this procedure). The levels of "significant impact level" (SIL) for NO_x and PM_{10} are also provided in Table 6.1.

Table 6.1: Class I Area PSD Increments and Modeling SIL Concentrations

Pollutant	Increment ($\mu g/m^3$)	SIL ($\mu g/m^3$)
NO_x - annual average	2.5	0.1
PM_{10} - annual average	4.0	0.2
PM_{10} - 24-hour maximum	8.0	0.3

The impacts on Air Quality Related Values (AQRVs) are also addressed. The United States Department of Agriculture (USDA) Forest Service (FS) has proposed a concern threshold for visual range (VR) and for acid neutralization capacity (ANC) of high-elevation lakes (http://www.fs.fed.us/r6/aq/ natarm/r4/ bridger_ct.htm). Impacts from the proposed Source #17 modification were compared to these thresholds. The threshold for visibility is a 5 percent change in beta extinction ($ß_{ext}$) and the threshold for ANC of high-altitude Class I wilderness lakes is the larger of the following:

- a relative change of 10 percent in ANC (eq) relative to baseline
- an absolute change in lake alkalinity of 1 µeq/l

The following Class I Area impact analysis is performed according to the November 2002 "Class I Area Impact Analysis Protocol" modified by the February 10, 2003, Wyoming DEQ comments on that protocol. The analysis detail presented in those documents will not be repeated herein.

6.2 AQRV Baselines

6.2.1 Visual Range Natural Background

The AQRV impact analyses incorporate baseline values. The VR analysis was based on measured values representative of "natural background" in the Class I areas. The measured constituent data for Bridger/Fitzpatrick is provided in Table 6.2.

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Table 6.2: Summary of Measured Background VR Parameters at the Bridger/Fitzpatrick IMPROVE Monitoring Site, 1988-1999

Season	Dry Hygroscopic (Mm^{-1})	Non-Hygroscopic (Mm^{-1})
Winter	0.81	1.96
Spring	1.99	3.41
Summer	1.91	6.10
Fall	1.40	3.60

The measured background VR values in Table 6.2 were calculated as follows. The data from 1988 to 2001 for the Interagency Monitoring of Protected Visual Environments (IMPROVE) site at Bridger/Fitzpatrick Wilderness (BRID1) were obtained from the IMPROVE website (http://vista.cira.colostate.edu/improve). Only data up to 1999 were included in the analysis, since the 2000 and 2001 data had not undergone the highest level of quality control. Background levels were calculated for non-hygroscopic and hygroscopic compounds separately. Per the Interagency Workgroup on Air Quality Modeling Phase 2 (IWAQM2, 1998), non-hygroscopic compounds include coarse particulate matter (PM_{10}-$PM_{2.5}$), elemental carbon, organic carbon, and soil particles; the hygroscopic compounds include ammonium nitrate and ammonium sulfate. Summaries were based on the seasons per the Federal Land Managers AQRV Work Group (FLAG, 2000), specifically winter (December, January, February), spring (March, April, May), summer (June, July, August), and fall (September, October, November). For each year-by-season combination the 20th-percentile value was calculated for the non-hygroscopic and hygroscopic $ß_{ext}$ values (units of Mm^{-1}). The background $ß_{ext}$ from 1988 through 1999 were calculated as the mean of the 20th-percentile values for each season. Only seasons with more than 50 percent of the data present were used in the analysis (Watson, 2002). Based on this criterion, the winter season in 1988 was excluded from the analysis.

6.2.2 Lake Acid Neutralization Capacity Baseline

Two parameters needed to be estimated to establish the baseline ANC: baseline lake alkalinity (µeq/l) and estimated annual precipitation (m). Baseline lake alkalinity was calculated as the 10th-percentile lake alkalinity values for six lakes in the region (FS, 2000). Data for the indicator lakes were provided by the USDA FS (FS, 2002) and are shown in Table 6.3. The lake elevations varied from 2,950 to 3,432 meters above sea level (m asl). The FS data set consisted of a time series of measurements of the baseline alkalinity, including duplicates, the number of which varied from year to year and lake to lake. The 10th-percentile values were calculated from the entire data set, covering up to an 18-year record (Table 6.3). Blanks and negative values were excluded from the calculation. Note that the Upper Frozen Lake was recently added to the set of "indicator lakes." Data collection at this lake began in 1997, and to date there have been four samplings: one day per year in July or August for 1997, 1999, 2000, and 2001. For two of the samplings, a duplicate was also collected, making a total of six available readings with a range of

11.4 µeq/l as the highest to 1.3 µeq/l as the lowest. From this extremely small data set, the 10th-percentile most sensitive ANC value is 2.0, which is very low.

Table 6.3: Baseline ANC for Indicator Lakes

Lake	Period of Records	Number of Observations	10th-Percentile Most Sensitive Lake Alkalinities (µeq/l)
Black Joe	1984 –2001	186	60.0
Deep	1984 –2001	172	60.1
Hobbs	1984 –2001	197	70.3
Ross	1985 –2001	140	55.7
Lower Saddlebag	1986 –2001	147	55.8
Upper Frozen	1997 –2001	6	2.0

The second estimated parameter needed to calculate baseline ANC is the annual precipitation at the lakes under consideration (FS, 2000). The annual precipitation at the high elevation lakes in the Class I areas was estimated as the 16-year average precipitation (period 1986 to 2001) based on data from two National Atmospheric Deposition Program (NADP) monitoring stations, Gypsum Creek (WY98) and Pinedale (WY06). The Pinedale site is located approximately 20 km south from the site used to monitor visibility in the Bridger/Fitzpatrick Wilderness Area (IMPROVE site BRID1) and approximately 40 km from the western border of the Bridger/Fitzpatrick Wilderness Area. The Gypsum Creek site is located within 5 km of the Bridger/Fitzpatrick Wilderness Area, and approximately 30 km north of Pinedale. Both sites are located at about 2,400 m asl. The estimated annual precipitation at these sites was 37 and 29 cm per year (approximately 14.6" and 11.4") for Gypsum Creek and Pinedale, respectively. To yield the more conservative estimate of the change in ANC, the higher precipitation rate at Gypsum Creek was used in the analysis.

6.3 Dispersion Analysis Approach

6.3.1 Model Selection

Because the Class I Areas are more than 50 km from the Solvay facility, long-range transport was applicable. The IWAQM2 Summary Report and Recommendations for Modeling Long-Range Transport Impacts, and the FLAG Report recommends the use of version 5.4 of the California Puff Model (CALPUFF) for evaluating impacts on a regional scale. CALPUFF is a multi-layer, gridded, non-steady-state lagrangian puff dispersion model that can simulate the effects of temporally and spatially varying meteorological conditions on pollutant transport and dispersion.

At Wyoming DEQ's request, the Southwest Wyoming Technical Air Forum (SWWYTAF) 1995 CALPUFF analysis (February 2001) was used as the basis for this analysis. The objective of the

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SWWYTAF study was to estimate air impacts on the Bridger/Fitzpatrick Class I Wilderness Areas caused by both natural and anthropogenic emission sources, and to evaluate the performance of the CALPUFF dispersion model and its associated California Meteorological Model (CALMET) wind field model. CALPUFF is a non-steady state model used for visibility and long-range modeling. Details of the SWWYTAF study are summarized below, with emphasis on the proposed changes from the SWWYTAF approach.

6.3.2 Geophysical Data

The modeling domain and geophysical data from the SWWYTAF study was used. The SWWYTAF modeling domain included the southwestern portion of Wyoming, northeastern Utah, southeastern Idaho, and northwestern Colorado, and consisted of 116 by 100 grid cells at 4-km spacing. This corresponded to a domain of 464 km in X (east west) by 400 km in Y (north south). The southwest corner had the coordinates of -335.0 in X and -258.0 in Y. The coordinate system is a Lambert Conic Conformal (LCC) coordinate system with standard latitudes of 30 and 60 degrees, reference latitude of 42.55 degrees, and reference longitude of 108.55 degrees. The SWWYTAF terrain data were extracted from a 1-degree DEM, which has an approximate grid spacing of 90 meters. The land use data were extracted from the USGS composite theme grid (CTG) 1:250,000 (1 degree) scale files. These data were processed for the SWWYTAF study and were contained in the GEOSWY.DAT file. A surface map of the CALMET and CALPUFF modeling domain is given in Figure 6.1.

6.3.3 Meteorological Data

The meteorological data were processed using CALMET. A sample CALMET input file is provided on the CD accompanying this report. In the SWWYTAF study, the time-varying large-scale wind flow was derived using a combination of the coarse-grid (20 km), the fifth-generation NCAR/Penn State Mesoscale Model (MM5) simulations, direct surface observations, and vertical soundings. Figure 6.1 also shows the locations of the meteorological input data.

The MM5 data were generated by the National Center for Atmospheric Research (NCAR) using the PSU/NCAR Mesoscale Model System, Version II. The data have 11 standard levels (surface; 1,000; 850; 700; 500; 400; 300; 250; 200; 150; and 100 hPa) and include a two-dimensional snow cover, the sea surface temperature, the sea level pressure, and three-dimensional variables of temperature, geo-potential height, U (positive eastwards) and V (positive northwards) components of wind, and relative humidity (RH).

In addition to the MM5 data, CALMET requires hourly surface observations of wind speed, wind direction, temperature, cloud cover, ceiling height, surface pressure, relative humidity, and precipitation type (e.g., snow, rain). For SWWYTAF, a total of 22 surface stations were used (Table 6.4). Hourly observations from these stations were processed for SWWYTAF and were used in this analysis.

Figure 6.1: CALMET and CALPUFF Modeling Domain
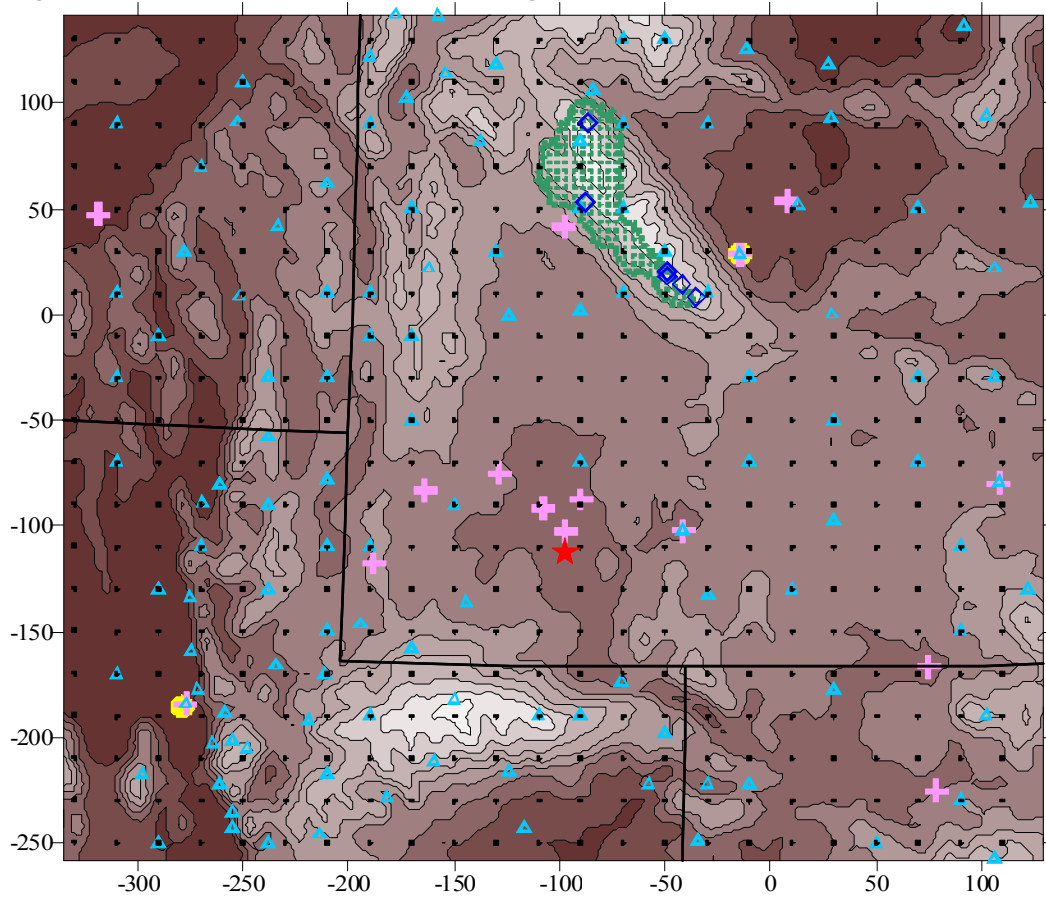
Legend:	Description	Symbol
	Terrain	Base: lighter colors indicate increasing elevation.
	Source location (Solvay)	Red star
	MM5 data grid	Black circles
	Surface air stations	Pink crosses
	Upper air stations	Yellow circles
	Precipitation stations	Light blue triangles
	Class I area receptors	Green circles
	High elevation lakes	Dark blue diamonds

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Table 6.4: Surface Meteorological Data Stations Used in the SWWYTAF Analysis

Surface Station	Source
Casper, WY	NWS
Cheyenne, WY	NWS
Denver, CO	NWS
Lander, WY	NWS
Grand Junction, CO	NWS
Pocatello, ID	NWS
Rock Springs, WY	NWS
Salt Lake City, UT	NWS
Rawlins, WY	FAA
Riverton, WY	FAA
Baggs, WY	Mt. Zirkel Study
Craig, CO	Mt. Zirkel Study
TG Soda Ash	Industrial Site
OCI	Industrial Site
Naughton	Industrial Site
General Chemical	Industrial Site
Amoco	Industrial Site
Exxon	Industrial Site
Pinedale	NDDN
Centennial	NDDN
Yellowstone NP	NPS
Craters of the Moon NP	NPS

CALMET also requires twice-daily observations of the vertical profiles of wind speed, wind direction, temperature, and pressure. For SWWYTAF, there were four sites observed for upper air data (Table 6.5). The data from these sites were processed for SWWYTAF and were used in this analysis.

Table 6.5: Upper Air Meteorological Data Stations Used in the SWWYTAF Analysis

Upper Air Station	Source
Denver, CO	Twice-daily upper air (TD6201) soundings (NWS)
Grand Junction, CO	Twice-daily upper air (TD6201) soundings (NWS)
Lander, WY	Twice-daily upper air (TD6201) soundings (NWS)
Salt Lake City, UT	Twice-daily upper air (TD6201) soundings (NWS)

In order to calculate wet deposition rates, CALMET requires hourly precipitation rates across the domain. Generally, most precipitation stations tend to be at lower elevations. However, because the presence of high terrain can substantially enhance the amount of precipitation, the use of only the lower level stations can result in an underestimate of the precipitation in areas of elevated

terrain. Therefore, in the SWWYTAF study, additional sources of precipitation data were used to properly characterize the precipitation patterns in the SWWYTAF domain. For SWWYTAF, 4-km resolution Parameter-elevation Regressions on Independent Slopes Model (PRISM) climatological precipitation data were used to convert the 20-km MM5 predictions to a 4-km resolution and to produce a more representative terrain-induced spatial pattern. Likewise, the observed hourly precipitation data were scaled by the PRISM annual values for consistency. The scaled MM5 data were combined with the scaled hourly precipitation observations to produce the final precipitation field. This scaled SWWYTAF precipitation file was used in this analysis.

6.3.4 Wind Field Generation

The time-varying wind fields were generated using the CALMET program and the SWWYTAF geophysical data file (GEOSY.DAT), MM5 data, surface data file (with RH pseudo stations added), upper air data files, and scaled precipitation data. CALMET was run using the model settings as used in SWWYTAF.

6.3.5 CALPUFF Settings and Execution

Once the CALMET wind fields were completed, the CALPUFF model was run to calculate concentrations, and wet and dry deposition rates of all relevant pollutants. For this analysis, the RIVAD/ARM3 chemistry transformation module was used, which included SO_2, SO_4, NO, NO_2, HNO_3, NO_3, and fine particulate species. The particulate emissions from the proposed source were modeled as PM_{10}.

The Class I area receptors from the SWWYTAF study were used. These receptors were placed every two kilometers along the boundary of each Class I area and on a 4-km resolution grid within each Class I area.

Building downwash parameters, as estimated by the BPIP (Version 95086), were incorporated into the CALPUFF analysis.

Hourly ozone data from the SWWYTAF study were used. This data includes O_3 measurements from six stations: Pinedale, WY; Centennial, WY; Yellowstone NP, WY; Craters of the Moon NP, ID; Highlands, UT; and Hayden, CO. The missing data hours were set to an O_3 concentration of 44.7 ppb, in accordance with SWWYTAF.

CALPUFF requires a domain average ambient ammonia (NH_3) concentration. The IWAQM2 recommended value of 1 ppb, representative of arid climates, was used in the model runs. Given the arid nature of the land and the low NH_3 emission fluxes (< 1 ton/sq mi/yr) in the modeling domain, the 1 ppb value was reasonable for this application. (See NH_3 emissions density map from EPA's National Air Pollution Emissions Trends Update, 1970-1997 [1998]; http://www.epa.gov/ttn/chief/trends/trends98/.) Furthermore, this value was corroborated

by a SWWYTAF impact estimate of 1.1 ppb region-wide, performed as an ancillary modeling exercise and based upon a region-wide NH_3 emission rate of approximately 0.23 ton/mi^2/yr.

The CALPUFF module was run using the proposed potential emissions (Table 2.3, Column #5) to calculate pollutant concentrations, and wet and dry deposition rates at each receptor in the Class I areas. Emissions from both Source #17, the calciners, and from Source #100, a baghouse, were included in the model runs.

The CALPUFF input file has been provided with this report on the accompanying CD.

6.4 PSD Increment Consumption

6.4.1 Methods

The annual average NO_2 and NO concentrations for all Class I area receptors were extracted from the model output using the CALPUFF Postprocessor (CALPOST) module. For each receptor these NO_2 and NO concentrations were added to obtain the annual NO_X concentration by receptor. The highest annual NO_X concentration was extracted from all receptors and compared to the SIL (Table 6.1). Similarly, the maximum 24-hour PM_{10} concentration and the annual average PM_{10} concentration were extracted from the CALPUFF output using CALPOST. The highest PM_{10} concentration for each averaging period was extracted from all receptors and compared to the SILs (Table 6.1).

Results of the NO_x and PM_{10} incremental impacts (the ground level concentrations) were compared with the allowable Class I PSD increments listed in Section 6.1. If the proposed emissions from Sources 17 and 100 triggered "significance" (Section 6.1), a cumulative increment analysis would be needed, and all domain increment-consuming emissions (as described in 5. 1) would need to be modeled.

6.4.2 Results

The results from the Class I significant impact threshold comparison analysis are shown in Table 6.6. The highest predicted concentrations in the Bridger/Fitzpatrick Wilderness Area were well below the SILs. Therefore, a full-scale cumulative increment analysis is not needed.

Table 6.6: CALPUFF Class I Area Impact Comparison with Significant Impact Level

Pollutant and Averaging Period	Receptor Number	Maximum Predicted Impact ($\mu g\ m^{-3}$)	PSD Class I Increment ($\mu g\ m^{-3}$)	Class I SIL ($\mu g\ m^{-3}$)
NO_X - Annual	197*	0.0051**	2.5	0.1
PM_{10} – Annual	182*	0.0011	4.0	0.2
PM_{10} – 24-hours	197*	0.0504	8.0	0.3

* Coordinates: 197- (-46.6, 5.2); 182- (83.9, 36.6)

** NO_X prediction consisting of 0.0048 and 0.0003 $\mu g/m^{-3}$ from NO_2 and NO, respectively.

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6.5 Visual Range

6.5.1 Methods

The CALPOST processor was used with the concentrations and the background relative humidity [f(RH)] values to calculate the light extinction (visibility impairment) in the Class I areas. For this analysis, the monthly background f(RH) values were used, as shown in Table 6.7. These f(RH) values were based on the *Draft Guidance for Tracking Progress Under the Regional Haze Rule*, Appendix A (EPA, September 2001) for each Class I area. Since the f(RH) values for the Bridger/Fitzpatrick Wilderness Area (Table 6.7) are similar, the higher of the two monthly f(RH) values was used for both Class I areas.

Table 6.7: Monthly Site-Specific f(RH) Values at the Bridger/Fitzpatrick Class I Area

Month	Bridger	Fitzpatrick	Month	Bridger	Fitzpatrick
January	2.52	2.51	July	1.50	1.51
February	2.35	2.33	August	1.49	1.46
March	2.34	2.24	September	1.74	1.73
April	2.19	2.13	October	2.00	1.98
May	2.10	2.09	November	2.44	2.39
June	1.80	1.80	December	2.42	2.44

The results were compared with the thresholds described in Section 6.2.1.

6.5.2 Results

The visual range analysis results are summarized in Table 6.8. The highest change in β_{ext} was 1.65 percent. The highest visibility impact occurred on a day with winds predominantly from the south that transported the emissions to the Class I area during most of the day (Figure 6.2). The VR analysis also showed that nitrate is the main contributor to the visibility impacts, accounting for 87 to 99 percent of the change in β_{ext} (Table 6.8).

Overall, the VR analysis indicated the 5 percent concern threshold for visibility in the Class I areas would not be exceeded based on the highest potential emissions from the proposed source.

Table 6.8: Visual Range Analysis Results

Date 1995	Receptor	β_{ext} (Mm^{-1})			Delta β_{ext} (%)	f (RH)	β_{ext} by Component (%)	
		Model	Background	Total			β_x NO$_3$	β_x PM$_{10}$
Jan. 25	173*	0.231	14.00	14.232	1.65	2.52	87	13
Dec. 16	195*	0.158	13.92	14.078	1.14	2.42	87	13
May 4	204*	0.157	20.13	20.289	0.78	2.10	98	2
May 25	167*	0.081	20.13	20.213	0.40	2.10	99	1
June 11	138*	0.071	19.56	19.627	0.36	1.80	96	4
Threshold					**5.0**			

* Coordinates: 173- (-104.5, 53.7); 195- (-52.4, 10.3); 204- (-45.5, 13.5); 167- (-109.9, 63.4); 130- (-93.0, 92.0)

Figure 6.2: Wind Fields (120 m) and NO$_2$ Concentration for January 25th, 1995 (12 pm).
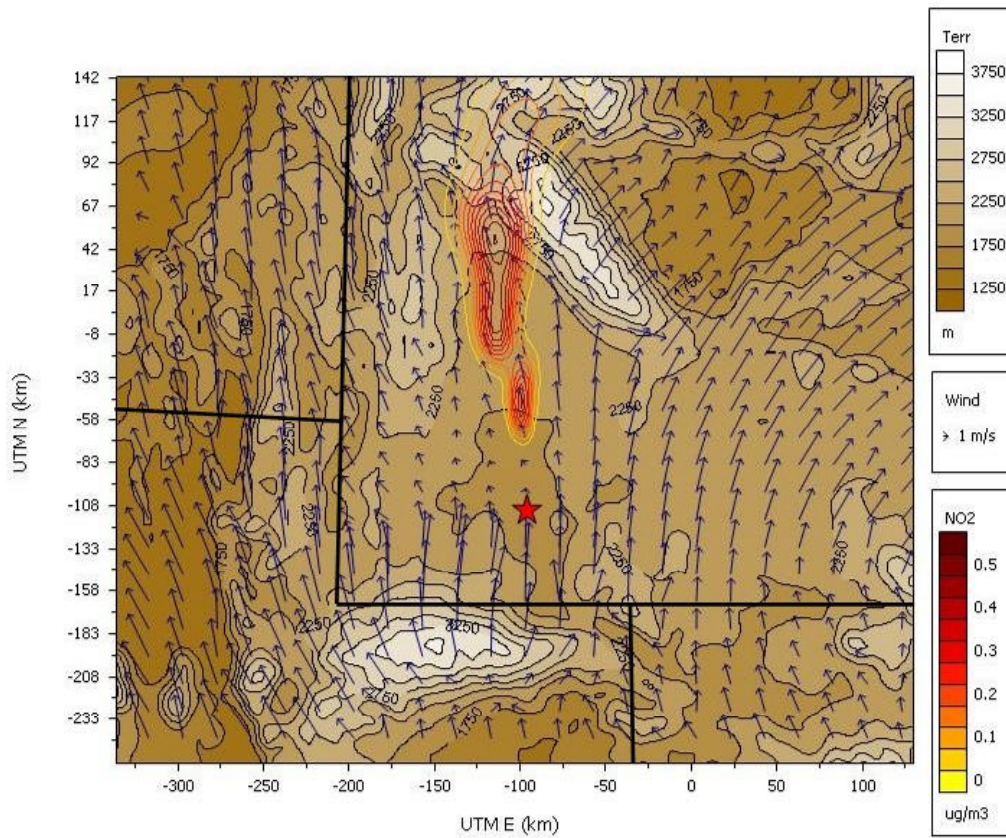
6.6 Change in Acid Neutralizing Capacity

6.6.1 Methods

The nitrogen (N) deposition rates were extracted from the CALPUFF output file using the POSTUTIL and CALPOST programs. POSTUTIL takes the CALPUFF wet and dry deposition files with the CALPUFF defined species (i.e., NO_2, HNO_3, $(NH_4)_2SO_4$) and calculates N deposition rates. The N deposition rates in the POSTUTIL output file (g/m^2 s) were calculated using the conversion factors according to the guidelines provided with POSTUTIL:

$$N \text{ deposition } (g/m^2 \text{ s}) = 0.304 \times NO_2 + 0.222 \times HNO_3 + 0.452 \times NO_3^{-1} + 0.292 \times SO_4^{-2}$$

Although not shown in the equation above, the nitrogen from the background ammonium was also included in the N deposition rate. CALPOST was used to extract the N deposition for all receptors. One specific receptor was established for each of the lakes, based on their latitude and longitude. The CALPUFF generated total N deposition was used in the calculation of the change in ANC, according to the methodology described in *Screening Methodology for Calculating ANC Change to High Elevation Lakes* (FS, 2000). Annual precipitation was estimated as described in Section 6.2.2. The baseline lake alkalinities are shown in Table 6.3. Results of the calculated change in ANC were compared with the AQRVs in Section 6.1.

6.6.2 Results

Table 6.9 summarizes the estimated change in ANC for each of the six high elevation lakes in the Bridger/Fitzpatrick Wilderness Area. The highest predicted change in ANC was found for the Upper Frozen Lake, which can be explained by the extremely low baseline alkalinity at this lake (Table 6.3, Table 6.9). However, even at the Upper Frozen Lake the predicted change in ANC was considerably below the AQRVs, both expressed on a percent basis and on a concentration basis (μeq/l). Thus, based on the highest potential emissions from the proposed source, the predicted change in ANC did not exceed the threshold for "potential to impact."

Table 6.9: Summary of Estimated Change in ANC for Six High Elevation Lakes

Lake Name	Lake Elevation* (m ASL)	Baseline ANC** (equivalents)	H⁺ Deposition*** (equivalents)	Change in ANC Percent	Change in ANC µeq/l
Black Joe	3,122	150	0.13	0.09	0.16
Deep	3,201	150	0.14	0.09	0.17
Hobbs	3,085	176	0.09	0.05	0.11
Ross	2,948	139	0.05	0.04	0.06
Lower Saddlebag	3,432	139	0.18	0.13	0.22
Upper Frozen	3416	5	0.18	2.88	0.17
Threshold				**10**	**1**

*   Estimated elevation based on the terrain file processed by CALMET.

**   Calculated based on baseline alkalinities provided by U.S. Forest Service, Table 6.3.

*** Based on CALPUFF output processed by POSTUTIL and CALPOST.

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COMPLIANCE DEMONSTRATION

This proposed furnace modification includes flue gas recirculation (FGR) for control of NO_x emissions. This is a process design modification for pollution control, so the Compliance Assurance Monitoring (CAM) Rule applies. Solvay anticipates using a form of parametric monitoring for the critical variables affecting NO_x emission from FGR, but requests to reserve the determination of the most appropriate method until the furnace design and controls are more thoroughly inspected by the vendor. Within 30 days, but not to exceed 90 days after start-up, compliance testing for NO_x will be conducted utilizing EPA Reference Method 7.

Particulate emissions from the furnace and calciner exhaust, Source #17, will be controlled by an electrostatic precipitator. A continuous opacity monitor will be operated for tracking particulate emissions, so the source is exempt from the CAM rule per 40 CFR 64.2(b)(i) in regard to particulate monitoring. After start-up, compliance testing for particulate will be conducted utilizing EPA Reference Methods 5 and 202, as required.

Source #100 will be equipped with a baghouse to control particulate emissions. Compliance will be verified with EPA Reference Method 9 for opacity after start-up.

SECTION 8
REFERENCES

FLAG, *Federal Land Managers' Air Quality Related Values Workshop (FLAG) Phase I Report*, December 2000)

EPA, FR July 23, 1996, pp. 38,249 – 38,344

IWAQM2, EPA-454/R-98-019, 1998

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Forest Service, *Users Guide - Screening Methodology for Calculating ANC Change to High Elevation Lakes,* 2000

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SWWYTAF, Earth Tech, Concord MA, *The Southwest Wyoming Regional CALPUFF Air Quality Modeling Study - Final Report including Project Data Files,* February 2001

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		PROJECT TITLE:		BY:		
AIR SCIENCES INC. DENVER · PORTLAND	**ENGINEERING** **CALCULATIONS**	Solvay Minerals Inc.		Ejaz Memon		
		PROJECT NO:		PAGE:	OF:	SHEET:
		170-4		1	4	1
		SUBJECT:		DATE:		
		Calciners A and B Emissions		November 15, 2002		

CALCINERS A & B (SOURCE # 17)

SOURCE CHARACTERISTICS

	Units	Existing	Modified
Control Device		ESP	ESP
Exhaust Flow Rate	ACFM	312,000	650,000
Trona Feed Capacity	TPH	400	320
Thermal Capacity	MMBtu/hr	500	400
Operation Schedule	hrs/yr	8,760	8,760
Fuel Type		Natural Gas	Sub-bituminous Coal

POTENTIAL EMISSION DIFFERENCE (tpy)

Pollutant	Existing	Modified	Difference
PM$_{10}$	97.7	180.2	82.5
NOx	131.4	788.4	657.0
CO	6,675.1	5,532.7	-1,142.4
VOC	3,398.9	2,714.0	-684.9

EMISSION DIFFERENCE FOR COMPARISON TO MAJOR SOURCE TRIGGER THRESHOLDS (tpy)

Pollutant	Existing Actual [a]	Modified PTE	Difference
PM$_{10}$	32.4	180.2	147.8
NOx	49.2	788.4	739.2
CO	1,077.4	5,532.7	4,455.3
VOC	1,199.2	2,714.0	1,514.7

[a] *Average of years 2,000 and 2,001 actual emissions, as reported to WYDEQ*

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AIR SCIENCES INC.	ENGINEERING CALCULATIONS	**Solvay Minerals Inc.**		**Ejaz Memon**		
		PROJECT NO:	PAGE:	OF:		SHEET:
		170-4	**2**	**4**		**1**
DENVER · PORTLAND		SUBJECT:		DATE:		
		Calciners A and B Emissions		**November 15, 2002**		

MODIFIED CONDITIONS
CALCINERS A & B (SOURCE # 17)

SOURCE CHARACTERISTICS

Reference

Furnace Type	Detroit Stoker Underthrow Fuel (Pneumatically Assisted) Spreader		
Control Device	ESP		
Exhaust Flow Rate	650,000 ACFM		Solvay
	240,000 DSCFM		Solvay
Trona Feed Capacity	320 TPH		Solvay
Thermal Capacity	400 MMBtu/hr		Solvay
Operation Schedule	8,760 hrs/yr		Solvay

FUEL DATA

Fuel Type	Sub-Bituminous Coal	Solvay
Heating Value	10,150 Btu/lb	Solvay
	20.3 MMBtu/ton	
Fuel Consumption	19.7 ton/hr	

$$\frac{400 \text{ MMBtu}}{\text{hr}} \quad \frac{\text{ton}}{20.3 \text{ MMBtu}}$$

EMISSION FACTORS

Pollutant	Emission Factor		
PM$_{10}$	0.02 grain/DSCF		Manufacturer Guarantee for ESP
	41.1 lb/hr		

$$\frac{0.02 \text{ grain}}{\text{DSCF}} \quad \frac{240,000 \text{ DSCF}}{\text{min}} \quad \frac{1 \text{ lb}}{7000 \text{ grain}} \quad \frac{60 \text{ min}}{\text{hr}}$$

NOx	0.45 lb/MMBtu	Manufacturer Guarantee
CO	5 lb/ton-coal	AP-42, Table 1.1-3 (Spreader Stoker)
	0.19 lb/MMBtu	AP-42, Table 1.1-3 (Based on 26 MMBtu/ton)
CO (process)	3.7 lb/ton-trona	See Calculations on Sheet 4
VOC	0.05 lb/ton-coal	AP-42, Table 1.1-19 (Spreader Stoker)
VOC (process)	1.9 lb/ton-trona	See Calculations on Sheet 4

POTENTIAL EMISSIONS

Pollutant	g/sec	lb/hr	tpy
PM$_{10}$	5.18	41.1	180.2
NOx	22.68	180.0	788.4
CO	159.16	1,263.2	5,532.7
VOC	78.07	619.6	2,714.0

STACK PARAMETERS

Location	603,686 m East	
	4,594,808 m North	
Stack Height	55.02 m	
Stack Diameter	3.66 m	
Exhaust Temperature	400 ^{o} F	
Exhaust Velocity	29.2 m/s	*Numbers in blue are entries, and black are calculations*

EXISTING CONDITIONS

CALCINERS A & B (SOURCE # 17)

SOURCE CHARACTERISTICS

			Reference
Control Device	ESP		Permit 30-126
Exhaust Flow Rate	312,000	ACFM	Permit 30-126
Trona Feed Capacity	400	TPH	Permit 30-126
Thermal Capacity	500	MMBtu/hr	Permit 30-126
Operation Schedule	8,760	hrs/yr	

POTENTIAL EMISSIONS

Pollutant	lb/hr	tpy	
PM_{10}	22.3	97.7	Permit 30-126
SO_2	0.0	0.0	Permit 30-126
NOx	30.0	131.4	Permit 30-126
CO	1,524.0	6,675.1	Permit CT-1347
VOC	776.0	3,398.9	Permit CT-1347

ACTUAL EMISSIONS [a]

	2000	2001	Average
Pollutant	tpy	tpy	tpy
PM_{10}	40.2	24.5	32.4
NOx	64.5	33.9	49.2
CO	1,322.0	832.8	1,077.4
VOC	1,446.1	952.3	1,199.2

[a] *Provided by Solvay Minerals Inc. as reported to WYDEQ as per requirement of permit 30-126*

STACK PARAMETERS

Location	603,686	m East
	4,594,808	m North
Stack Height	55.02	m
Stack Diameter	3.66	m
Exhaust Temperature	375	°F
Exhaust Velocity	13.41	m/s

Numbers in blue are entries, and black are calculations

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AIR SCIENCES INC. ENGINEERING CALCULATIONS	Solvay Minerals Inc.	Ejaz Memon		
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	SUBJECT:	DATE:		
DENVER · PORTLAND	Calciners A and B Emissions	November 15, 2002		

CALCINERS A & B (SOURCE # 17) - ESTIMATION OF CO AND VOC EMISSION FACTORS (PROCESS ONLY)

EXISTING CONDITIONS

			Reference
Thermal Capacity	500	MMBtu/hr	Permit 30-126
Trona Feed Capacity	400	TPH	Permit 30-126
Total CO (Process + Combustion) Emissions	1524	lb/hr	Permit CT-1347
CO (Natural Gas Combustion) Emissions	84	lb/MMScf	AP-42 Table 1.4-1
	0.08	lb/MMBtu	(Based on 1,020 Btu/Scf)
	41.2	lb/hr	
CO (Process) Emissions	1482.8	lb/hr	
	3.7	lb/ton-ore	
Total VOC (Process + Combustion) Emissions	776.0	lb/hr	Permit CT-1347
VOC (Natural Gas Combustion) Emissions	5.5	lb/MMScf	AP-42 Table 1.4-2
	0.005	lb/MMBtu	(Based on 1,020 Btu/Scf)
	2.7	lb/hr	
VOC (Process) Emissions	773.3	lb/hr	
	1.9	lb/ton-ore	

Numbers in blue are entries, and black are calculations

SOLVAY2016_1.3_000351

		PROJECT TITLE:		BY:		
AIR SCIENCES INC.	**ENGINEERING** **CALCULATIONS**	**Solvay Minerals Inc.**		**Sareth Prum**		
		PROJECT NO:	PAGE:	OF:		SHEET:
		170-4	**1**	**1**		**1**
DENVER · PORTLAND		SUBJECT:		DATE:		
		New Coal Bunker Baghouse Emissions		**December 2, 2002**		

NEW COAL BUNKER BAGHOUSE EMISSIONS (SOURCE # 100)

SOURCE CHARACTERISTICS

Reference

Control Device	Baghouse	
Exhaust Flow Rate	3,000 ACFM	Solvay
	2,366 DSCFM	Solvay
Operation Schedule	8,760 hrs/yr	Solvay

EMISSION FACTORS

Pollutant	**Emission Factor**			
PM$_{10}$	0.01 grain/DSCF		Manufacturer Guarantee	

$$0.2 \text{ lb/hr} \quad \frac{0.01 \text{ grain}}{\text{DSCF}} \quad \frac{2,366 \text{ DSCF}}{\text{min}} \quad \frac{1 \text{ lb}}{7000 \text{ grain}} \quad \frac{60 \text{ min}}{\text{hr}}$$

POTENTIAL EMISSIONS

Pollutant	**g/sec**	**lb/hr**	**tpy**
PM$_{10}$	0.02555	0.2	0.9

STACK PARAMETERS

Location	603,681 m East	
	4,594,817 m North	
Stack Height	38.40 m	
Stack Diameter	0.3048 m	
Exhaust Temperature	Ambient ^{o} F	
Exhaust Velocity	19.4 m/s	*Numbers in blue are entries, and black are calculations*

APPENDIX B

BACT Review References

Evaluation of Pulverized Coal Firing for a Calciner Air Heater

A Report for

Solvay Minerals Company

by

Dr. Kevin A. Davis

Reaction Engineering International

and

Dr. N. Stanley Harding

N.S. Harding & Associates

OBJECTIVE

To provide Solvay Minerals Company with estimates of potential NO_x emissions from a pulverized coal-fired furnace system to be retrofitted into their calcining process.

BACKGROUND

Currently, Solvay Minerals Co. in Green River, Wyoming operates a gas-fired furnace for generating a hot gas stream that is used in their trona calcining process. There is no steam or electricity production associated with this retrofit system and the natural gas-fired furnace is refractory-lined for process efficiency. The hot gases are then used to remove the CO_2 from the trona ore (calcining). Any excess heat in the gas is used to preheat the combustion air used in the furnace.

Originally, a coal spreader-stoker firing system was used to generate the hot gas for the process. As economics changed, a gas-fired system was installed and the spreader-stoker was removed. In the current environment, the cost and availability of local coal make it more economical than gas, the decision to convert back to coal firing is being entertained.

Solvay Minerals prepared the request to the Wyoming State Environmental division to permit them to change from the gas-fired system to a coal spreader-stoker system enhanced with currently available NO_x controls. The State has requested that Solvay investigate the potential for using a pulverized coal system with advanced NO_x control in order to minimize NO_x emissions. Solvay, in turn, has requested that Reaction Engineering International (REI) in Salt Lake City provide support for this endeavor.

REI PROGRAM

REI was requested specifically to perform the following tasks:

- Review with Solvay personnel key process conditions and constraints at the Green River, WY site.

SOLVAY2016_1.3_000354

- Identify and summarize potential technologies for pulverized coal firing

- Develop a list of potential suppliers of pulverized coal-fired furnaces and burners in the size range compatible with the Solvay process.

- Prepare a Request for Information for the potential suppliers and solicit responses.

- Identify and summarize relevant vendors

- Preparation of a quotation summary and critical evaluation

The first five tasks have been completed and this report provides the results.

DISCUSSION AND RESULTS

Reaction Engineering International (REI) personnel have held several discussions with Solvay Minerals personnel to obtain a thorough understanding of the calcining process in order to solicit information from potential suppliers of pulverized coal-fired furnaces and burners. Based on these discussions, the following list of operating conditions and process constraints was prepared:

- The total furnace heat input needs to be 200 MMBtu/hr.

- The coal to be used is a local Wyoming subbituminous coal.

- Due to existing process equipment, the maximum footprint and height dimensions for the retrofit furnace are:
    o Above ground – 40 ft (wide) x 33 ft (deep) x 62 ft (high)
    o Directly below ground – 40 ft (wide) x 58 ft (deep) x 22 ft (high)

- Existing equipment does not include a pulverizer, water or steam handling system or turbine and generator.

- Due to utilization of the hot flue gas in the process, the maximum air preheat temperature currently available is 225°F.

- Limited space is available at the plant site for locating new equipment.

The focus of the entire inquiry was to obtain an idea of the potential NO$_x$ emission from a pulverized coal system. This would be compared with the current emission level and the emission level estimated from a stoker-fired boiler.

With this information, REI prepared the request for information as shown in Figure 1 on the following page. This information provides enough detail so that the potential furnace and/or burner suppliers could determine if they would be interested in providing the necessary equipment for the retrofit. In addition, the desire was to receive an indication of the predicted NO$_x$ emission from their system.

Figure 1.

REQUEST FOR INFORMATION:
PULVERIZED COAL-FIRED FURNACE

Reaction Engineering International, an Engineering firm headquartered in Salt Lake City, UT specializing in computational fluid dynamic (CFD) modeling, is seeking information from potential suppliers of small industrial-scale furnaces which could produce a hot flue gas (1700^oF - 1800^oF) that would be used in a calcining process. Currently there is a gas-fired furnace (no waterwalls) that needs to be replaced for economic reasons. *Of primary importance is the anticipated NO_x emission from the pulverized coal-fired unit.*

The following is additional information that may be of help in determining the projected NO_x emission level:

➤ The total firing rate for the furnace is $200.x10^6$ Btu/hr; this can be done with one or two burners.

➤ Due to existing calciners and other process equipment, the maximum available footprint and height dimensions for locating the furnace are:

- o Above ground level: 40 ft (wide) x 33 ft (deep) x 62 ft (high)
- o Directly below ground: 40 ft (wide) x 58 ft (deep) x 22 ft (high)

➤ The coal available is a Wyoming subbituminous coal with the following analysis:

COAL ANALYSIS	
	As Received
Moisture, wt %	15.3
Ash, wt %	6.5
Carbon, wt %	60.6
Hydrogen, wt %	4.2
Nitrogen, wt %	1.4
Sulfur, wt%	0.5
Oxygen, wt %	11.5
HHV, Btu/lb	10,250

➤ Currently there is **no** pulverizer, **no** water or steam handling system and there is **no** turbine or generator on site. The current facility just produces hot flue gas.

➤ Combustion air is available but has a maximum temperature of 225^oF due to process constraints.

Specific information requested:

➤ Can you supply a pulverized coal furnace in the 200 MMBtu/hr range?

➤ Given the constraints listed above, what would you guarantee as a NO_x emission level?

There are four major utility boiler manufacturers in the United States; they are Alstom, Babcock & Wilcox, Foster Wheeler, and Babcock Power Inc. (Riley Stoker). Three of these were contacted (Babcock & Wilcox, Foster Wheeler and Babcock Power) and the fourth, Alstom, has only limited experience with a wall-fired furnace and burner; therefore they were not contacted. In addition to the major boiler/burner manufacturers, Johnston Boiler an industrial boiler/burner manufacturer was contacted. The final contact was Black & Veatch, a reputable Architecture and Engineering (A&E) firm that specializes in boilers and furnaces. They have access to and have worked with many of the smaller furnace/burner manufacturers throughout the world. The following paragraphs summarize the responses from each contact. The entire written responses from each contact are contained in Appendix A.

Foster Wheeler

Mr. Stefan Laux, Manager of Combustion Systems at Foster Wheeler, was contacted. After a couple of discussions with Stefan, he called and said that he would estimate a NO_x emission of about 1.5 lbs/MMBtu due to the necessary refractory walls in the furnace. He felt that this would not be of interest to Solvay since the emissions are so high. Mr. Laux did not provide a written response, only verbal.

Babcock & Wilcox

Mr. Ron Lenzer was contacted at Babcock & Wilcox. In brief, his response was that "a technical response to your request requires a level of engineering effort which we would not invest unless there were a strong chance of B&W ultimately winning a sale." If Solvay were interested in proceeding with B&W, they should contact the nearest B&W Sales Office.

Babcock Power Inc.

Mr. Kevin Davis provided the response from Babcock Power. In essence, their response was similar to B&W's. They estimate it would take 18-20 weeks and cost between $55,000 and $60,000 to complete the necessary study to design the furnace and estimate the NO_x emissions. Again, if Solvay was interested in pursuing this with Babcock Power, they should contact either the Sales Office in Salt Lake City, UT or the Western Regional Office in Phoenix, AZ.

Johnston Boiler

Mr. David Thornock replied that Johnston Boiler is currently not offering pulverized coal-fired boilers or pulverized coal-fired combustion retrofit systems.

Black & Veatch

Mssrs. Mike King and Mark Dittus were contacted and provided with the system information. They thought that it was possible to provide the retrofit, but verbally they estimated the uncontrolled NO_x would be about 1.2 – 1.5 lbs/MMBtu. They contacted some of their clients who fabricate furnaces and burners. Two initial responses were received. The first, from General Electric – Energy & Environmental Research (GE-EER) mentioned that they felt they were well suited to provide the system, but needed to know the amount of money available, the payback time required and if the ash and unburned carbon would affect the process. No further information has been received from this potential supplier.

The second company, Damper Design, Inc., mentioned they looked at this or a similar process over 10 years ago with "favorable" conclusions. In fact, they have done NO_x emissions testing at the 80-100 MMBtu/hr range in a refractory-lined test furnace. Damper Design would fire about 5% of the currently used natural gas in a 10 MMBtu/hr duct burner that would be needed to assure drying of the coal by heating the primary air up to 375°F. In addition, they recommend micronized coal (70% less than 400 mesh [37μ]) rather than just pulverized coal (70% less than 200 mesh [74μ]) to avoid flame impingement and improve particle burnout. Two companies, Williams and Fuller, offer pulverizers that will meet the micronized coal requirement. They also mentioned that the coal is not the best for NO_x control; that perhaps a PRB coal from northern Wyoming could be delivered at about \$0.80-\$1.00/MMBtu and result in even lower NO_x emissions. This cost is based on a project they did in Colorado where the PRB coal was delivered at \$1.20/MMBtu. With the stipulations of micronized coal and an in duct heater using ~5% gas, Damper Design would guarantee a NO_x emission of 0.35 lbs/MMBtu and, if the moisture in the coal was over 25%, they would guarantee 0.30 lbs/MMBtu. Further, if a PRB coal was used, they felt they could get NO_x emissions levels down in the 0.25 lbs/MMBtu range.

CONCLUSIONS

Based on the information received, one prospective supplier, Damper Design, felt confident they could guarantee 0.35 lbs NO_x/MMBtu if they used 5% gas in an in duct heater and micronized coal. Others chose not to respond due to the costs required to complete an accurate estimation of the emissions. Verbal estimates of the NO_x emissions were about 1.2 to 1.5 lbs/MMBtu due to the hot refractory walls.

APPENDIX A

WRITTEN RESPONSES FROM POTENTIAL SUPPLIERS

BABCOCK & WILCOX RESPONSE

Stan Harding

From:	"Lenzer, Ron" <rclenzer@babcock.com>
To:	"Stan Harding" <nshjr@attglobal.net>
Cc:	"Cioffi, Paul" <plcioffi@babcock.com>
Sent:	Tuesday, January 28, 2003 7:10 AM
Attach:	BurnerInfotoSuppliers.doc
Subject:	Re: PC Industrial Furnace

Stan,

Unfortunately, a technical response to your
request requires a level of engineering effort which we would not invest
unless there were a strong chance of B&W ultimately winning a sale. If that
is indeed the case, then your request should be sent to the nearest B&W
Sales office.

Regards,

Ron

BABCOCK POWER INC.

Stan Harding
_____

From:	\<kdavis@bbpwr.com>
To:	"Stan Harding" \<nshjr@attglobal.net>
Cc:	\<bfaia@bbpwr.com>; \<kpatel@bbpwr.com>; \<cpenterson@bbpwr.com>; \<ktoupin@bbpwr.com>; \<jpeck@mvpsic.com>; \<tmartinko@bbpwr.com>
Sent:	Thursday, February 06, 2003 10:51 AM
Subject:	Pulverized Coal Fired Furnace - Inquiry No. 501234

Good Morning Mr. Harding:

Let me first apologize that a response to your request has not been very timely in being prepared and hopefully the delay hasn't resulted in any significant inconvenience.

The objective as understood is to replace the existing gas fired furnace with a pulverized coal fired furnace to support a calcining process. It was stated that consideration of fuel changes were being driven by economics.

If site conditions are presently undeveloped to handle coal, consideration will certainly need to be given to preparation aspects such as fuel handling. Specifically, unloading; stockpiling (duration); conveyance; pre-drying; bunkering; etc. These are issues which we would not become involved with and you would need to have addressed by others.

We could perform a technical evaluation to establish the fuel side coal delivery system from the bunker outlet to the combustor outlet. Specifically, feeder(s); pulverizer(s); coal pipe(s); burner(s); and combustion chamber. An air system to support the combustion process would also need to be evaluated. Specifically, this would include fan(s); motor(s); ductwork; duct heater(s); controls; etc. Electrical interface such as switchgears; cable trays; control room modifications; etc. would need to be addressed by someone other than our company.

Although you've provided an analysis of the proposed coal and proposed firing rate, without having a specific furnace design with which to calculate BAHR and account for the refractory lining, predicting NOx emissions is impossible at this time.

To review and establish basic system requirements as well as prepare a proposal drawing and cost estimate for the combustion system equipment from the bunker outlet to the combustor outlet, as well as to establish requirements and cost estimate of the supporting combustion air system, we would estimate the development cost of somewhere between $55K and $60K assuming availability and detail of plant drawings including location of the proposed coal bunker. Travel and living expenses associated with site visits or offsite meetings have not been included in the above estimate. Evaluation on system feasibility could also proceed on a time and material basis if deemed to be a more cost effective manner.

2/7/2003

BABCOCK POWER INC. (CON'T.)

This offering would be subject to reaching mutually agreeable terms and conditions prior to proceeding. The above estimate is also exclusive of any sales, use or other applicable tax. The duration of the proposed study is subject to workload demands which would need to be reviewed at time of sale. Presently we'd estimate 18 - 20 weeks to complete the study effort after notice to proceed.

Thank you for your consideration of possible participation on the part of our company in this particular effort. If you have any questions regarding this offering, or would like additional information, please contact our sales agent in Utah who is Mr. John Peck of Mountain View Power & Industrial, Inc. located in Salt Lake City. John's phone number is (801)973-4455. Another contact would be Mr. Tom Martinko who is our Western Regional Sales Manager. Tom is located in Phoenix and can be reached at his office @ (623)875-6778.

Kevin G. Davis
Babcock Power Inc.
5 Neponset Street
Worcester, MA 01606
Tel: (508) 854-3818
Fax: (508) 853-3944

JOHNSTON BOILER

Stan Harding

From:	"David Thornock" <davidthornock@johnstonburner.com>
To:	"'Stan Harding'" <nshjr@attglobal.net>
Sent:	Friday, January 31, 2003 7:43 AM
Subject:	RE: PC Furnace

Stan,

Johnston Boiler Company is not currently offering PC fired boilers or PC fired combustion retrofit systems. Unfortunately we will be unable to assist you by supplying equipment on this job.

If there is any consulting work or review that needs to be done on this job, we are very willing to help out.

Regards,

David Thornock

BLACK & VEATCH
GENERAL ELECTRIC – ENERGY & ENVIRONMENTAL RESEARCH

Stan Harding

From:	<todd.melick@ps.ge.com>
To:	<DittusM@bv.com>
Sent:	Tuesday, February 04, 2003 7:41 AM
Subject:	RE: Solvay PC Furnace

I am still out from a double hernia operation. Just started reading email at home. Have not heard much from Eagleair for awhile. Yes we have seen some other coal for gas opportunities pop up. With our R&D background we would be well suited, this is not going to be off the shelf for anyone. How serious are they and how much money do they have? How many year payback would be attractive to them? Will the ash and UBC effect the process? Obviously we missed the February 1 target, what is the status now? These opportunities have a habit of disappearing when the gas price goes back down.

-----Original Message-----
From: Dittus, M. H. (Mark) [mailto:DittusM@bv.com]
Sent: Monday, February 03, 2003 3:53 PM
To: Melick, Todd (PS, EER)
Subject: FW: Solvay PC Furnace

Todd,

Following is an email and data on a project we have been approached about in Wyoming. The client is concerned with the unsure natural gas market and wants to see if it is feasible to convert their existing natural gas fired furnace to coal firing. The furnace is used strictly to produce hot gas for their calcining process, there is no steam or hot water produced at all.

The first questions we have are is this something Eagleair would be intersted in, what type of NOx emissions could you make and what type of performance guarantees would you be willing to provide.

I would appreciate any input you could provide on these questions, even a straight "we're not interested". If you have questions I let me know, I can try to answer them as best I can, unfortunately this project is so early in the stages I don't have a lot of information right now.

Regards,
Mark

**BLACK & VEATCH
DAMPER DESIGN, INC.**

Stan Harding

From: "Don Hagar" <damperd@gunnison.com>
To: "Dittus, Mark" <dittusm@bv.com>; "Peter Herrmann" <pherrmann@damperdesign.com>
Sent: Tuesday, February 04, 2003 7:03 AM
Subject: Calciner Burner for Solvay

Mark,

We looked at this over 10 years ago with favorable conclusions. I have lost the file, but the data is easily reconstructed. We felt we could replace 95% of the gas with coal.

Test firing we did several years ago in CE's refractory lined combustion chamber confirmed that the sole difference in NOx formation in such a furnace is peak flame temperature. This is controlled in our burner by the final venturi diameter. A 45% venturi is proven to achieve this. Water wall furnaces work very nicely with a 50% venturi.

Either one or two burners is feasible, but we would prefer two as being more certain of emissions results.

To avoid thermal NOx with the 45% venturi, the flame length would have to be close to 20 feet. A 26 to 30 foot deep chamber would avoid deposit problems. A 24 foot width with the burners 10 feet apart would avoid flame interaction and wall impingement.

Low combustion air temperature will cause high ash carbon, perhaps as high as 30%. Micronized coal would help reduce this, but we lack experience to offer a prediction on how much. The pulverizer will need a 10 mmBtu duct burner to assure drying of the coal by heating the primary air from 225 to 375° F.

The selected coal is not the best for NOx control. The best we could guarantee is 0.35 #/mmBtu. If the coal moisture were over 25%, we could guarantee 0.30 #/mmBtu. We would expect to demonstrate during testing levels 15% below these values (0.30 and 0.26).

Let me know if I need to answer any other questions.

Don

Mark,

I forgot to mention that exit temperature has to be controlled with dilution air. The burner gas temperature will be about 2,550° F.

We can't use high excess air to control temperature, it would raise NOx formation. I propose a maximum 13% excess air on the burners.

Don

Detroit Stoker Company

Subsidiary of United Industrial Corporation
1510 East First Street ● PO Box 732 ● Monroe, MI 48161-0732
(734) 241-9500 ● FAX (734) 241-7126 ● E-Mail: sales@detroitstoker.com
www.detroitstoker.com

E-mailed only: dolly.potter@solvay.com

February 11, 2003

Ms. Dolly Potter
Solvay Minerals, Inc
P.O. Box 1167
Green River, WY 82935

Subject: Solvay Minerals, Inc
         Green River, WY
         Detroit Stoker Company Job No. ES-111-RG-969

Dear Ms. Potter,

Pursuant to yesterday's telephone conversation regarding SNCR (Selective Non-Catalytic Reaction), Detroit Stoker Company offers the following information.

Detroit Stoker Company is not a designer or provider of Urea/ammonia based SNCR systems. However, we do have experience with these systems in the industrial boiler market, at both domestic and foreign locations. These experiences are predominately biomass fired facilities, but we also have experience with coal fired facilities.

Detroit Stoker Company has been involved in many requests for NOx reduction for both new and existing facilities. With those facilities having an SNCR system we have been successful at fully removing the SNCR and using a variety of technologies including staged combustion systems, flue gas recirculation and reburn technologies to obtain the necessary NOx reductions. Therefore Detroit's experience is based on replacement of SNCR's rather then adding on additional processes. It is also noteworthy that our experience is actually for boilers, rather then refractory lined furnaces. In fact, Detroit Stoker Company has no knowledge of an SNCR system in operation for a refractory lined process furnace.

An SNCR's effectiveness is dependent on a particular temperature window and resonance time (mixing) at those temperatures. Given that we have no experience with using an SNCR on a refractory lined process furnace it would be difficult to know if an SNCR would provide any NOx reduction. However, we are reasonably confident in saying that any reduction would not likely approach a 35-40% reduction value demonstrated on industrial coal fired boilers using an SNCR. Again our experience has been to replace an SNCR do to the operating costs, issues of ammonia slip and other operation/maintenance issues associated with SNCR's rather then co-operating with other "in-furnace" technologies.

We trust this information has been helpful and should you have any additional questions or concerns, please do not hesitate contacting either Dave Cron or me.

Sincerely,

Robert S. Morrow
Manager-Engineering

CC: William Stuble
    Solvay Minerals Inc
    bill.stuble@solvay.com

APPENDIX C

Class II Impact Model Results

Sheet C.1: Estimation of O_3 Increment from VOC and NO_x Emissions
Using VOC/NOx Point Source Screening Tables (Richard D. Scheffe)

VOC Emission	1514.74 tpy
NOx Emission	739.23 tpy
VOC/NOx Ratio	2.0

Using Table 1 of VOC/NOx Point Source Screening Tables for Rural Conditions
The applicable column in Table 1 is column 3:

Column 3 value for VOC emission rate of   1500   tpy is   3.3 pphm
Column 3 value for VOC emission rate of   2000   tpy is   3.7 pphm

By linear interpolation:
Column 3 value for VOC emission rate of   1514.7 tpy is   3.312 pphm

Thus, the O_3 increment from VOC emission is   0.033 ppm

$$\frac{3.31 \text{ pphm}}{} \quad \Big| \quad \frac{1 \text{ ppm}}{100 \text{ pphm}}$$

     3.31E-08 m^3 O_3 increment per m^3 of air

At ambient conditions (20 ^{o}C, 1 atm), 1 mole of a gas occupies   0.024057 m^3

   3.31179E-08 m^3 O_3 /m^3 equals   1.377E-06 mole/m^3

$$\frac{1 \text{ mole}}{0.024057 \text{ m}^3} \quad \Big| \quad \frac{3.3118\text{E-08 m}^3\ O_3}{}$$

                      6.608E-05 g/m^3

$$\frac{0.000001 \text{ mole } O_3}{} \quad \Big| \quad \frac{48 \text{ g}}{\text{mole } O_3}$$

                      66.1 ug/m^3

$$\frac{6.608\text{E-05 g}}{\text{m}^3} \quad \Big| \quad \frac{1000000 \text{ ug}}{\text{g}}$$

Background O_3 Concentration	161 ug/m^3
Ambient O_3 Concentration	227.1 ug/m^3

Sheet C.2: Table 1. Rural based O$_3$ increment (pphm) as a function of NMOC emissions and NMOC/NOx ratios

NMOC EMISSIONS (TONS/YR)	NMOC/NOx TONS NMOC/TONS NOx (PPMC/PPM)		
	> 20.7 (> 20) (COL 1)	5.2 - 20.7 (5 - 20) (COL 2)	< 5.2 (<5) (COL 3)
50	0.4	0.4	1.1
75	0.4	0.4	1.2
100	0.4	0.5	1.4
300	0.8	1.0	1.7
500	1.1	1.4	1.9
750	1.6	1.9	2.3
1000	2.0	2.4	2.7
1500	2.7	3.0	3.3
2000	3.4	3.8	3.7
3000	4.8	5.2	4.3
5000	7.0	7.5	4.8
7500	9.8	10.1	5.1
10000	12.2	12.9	5.4

Sheet C.3: HAP Impact and Risk Assessment

Source 17 NO$_x$ Emissions and Maximum Annual Impact

Source	Emission g/sec	Maximum Impact ug/m^3
Source 17	21.266	0.634

HAP Emissions Based on AP-42 Tables 1.1-14 and 1.1-18 (ESP Controlled Emission Factors)

HAP	Emission Factor lb/ton	Emission lb/hr [a]	g/sec
Arsenic	4.1E-04	8.1E-03	1.0E-03
Benzene	1.3E-03	2.6E-02	3.2E-03
Beryllium	2.1E-05	4.1E-04	5.2E-05
Ethylbenzene	9.4E-05	1.9E-03	2.3E-04
Formaldehyde	2.4E-04	4.7E-03	6.0E-04
Hexane	6.7E-05	1.3E-03	1.7E-04
Mercury	8.3E-05	1.6E-03	2.1E-04
Toluene	2.4E-04	4.7E-03	6.0E-04
Xylene	3.7E-05	7.3E-04	9.2E-05

[a] Based on 19.7 ton/hr coal consumption

Estimated Maximum Impacts Compared with Chronic Effect Thresholds and Risk Factors

HAP	Chronic Effect Threshold mg/m^3	ug/m^3	Source	Maximum Impact [b] ug/m^3	Risk Factor 10^{-6}	Cancer Risk	Chronic Threshold Exceeded
Arsenic	5.0E-05	5.0E-02	IRIS [c]	3.0E-05	2.0E-04	1.5E-07	NO
Benzene	6.0E-02	6.0E+01	CalEPA [d]	9.6E-05	1.3E-01	7.4E-10	NO
Beryllium	2.0E-05	2.0E-02	IRIS [c]	1.6E-06	4.0E-04	3.9E-09	NO
Ethylbenzene	1.0E+00	1.0E+03	IRIS [c]	7.0E-06	N/A	N/A	NO
Formaldehyde	4.0E-03	4.0E+00	ATSDR [e]	1.8E-05	8.0E-02	2.2E-10	NO
Hexane	2.0E-01	2.0E+02	IRIS [c]	5.0E-06	N/A	N/A	NO
Mercury	3.0E-04	3.0E-01	IRIS [c]	6.1E-06	N/A	N/A	NO
Toluene	4.0E-01	4.0E+02	IRIS [c]	1.8E-05	N/A	N/A	NO
Xylene	4.0E-01	4.0E+02	ATSDR [e]	2.7E-06	N/A	N/A	NO

Cumulative Risk — 1.6E-07

[b] Annual maximum impacts calculated as toxin emission rate times the ratio of NO$_x$ impact to NO$_x$ emission rate

[c] EPA Integrated Risk Information System (IRIS) Inhalation Reference Concentration (RfC)

[d] California EPA (CalEPA) Chronic Reference Exposure Level

[e] Agency for Toxic Substances and Disease Registry (ATSDR) Chronic Exposure Minimal Risk Level (MRL)

Sample Calculations:

Arsenic Emission 8.1E-03 lb/hr

$$\frac{4.1\text{E-}04 \text{ lb-As}}{\text{ton-coal}} \times \frac{19.70 \text{ ton-coal}}{\text{hr}}$$

1.0E-03 g/sec

$$\frac{8.1\text{E-}03 \text{ lb-As}}{\text{hr}} \times \frac{453.6 \text{ g}}{\text{lb}} \times \frac{1 \text{ hr}}{3600 \text{ sec}}$$

Arsenic Impact 3.0E-05 ug/m^3

$$\frac{0.63404 \text{ ug-NO}_x}{\text{m}^3} \times \frac{1 \text{ sec}}{21.27 \text{ g-NOx}} \times \frac{1.0\text{E-}03 \text{ g-As}}{\text{sec}}$$

Arsenic Risk 1.5E-07

$$\frac{3.0\text{E-}05 \text{ ug-As}}{\text{m}^3} \times \frac{\text{m}^3}{2.0\text{E-}04 \text{ ug-As}} \times \frac{1}{1.0\text{E+}06}$$